MAIN CURRENTS

IN MODERN THOUGHT

SIXTH SUMMER WORKSHOP
of
The Foundation for Integrated Education
at
Oregon State College, Corvallis, Oregon
from
Monday, June 23rd to Saturday, June 28th

Chairmen:

DR. HENRY MARGENAU, Yale University

DR. GEORGE A. LUNDBERG, University of Washington

DEAN SCHILLER SCROGGS, Oklahoma A. and M. College

For details, see page 3

VOL. 9 NO. 1

BOSTON UNIVERSITY
COLLEGE OF LIBERAL ARTS
LIBRARY

MAIN CURRENTS IN MODERN THOUGHT

A co-operative journal to promote the free association of those working toward the integration of all knowledge through the study of the whole of things, Nature, Man, and Society, assuming the universe to be one, dependable, intelligible, harmonious.

VOL. 9 NO. 1 (Issued March, 1952) $3 A YEAR, PUBLISHED QUARTERLY

The Journal of the Foundation for Integrated Education, 246 East 46th St., New York 17, N. Y.

"Ah, but a man's reach should exceed his grasp, or what's a heaven for?" — BROWNING

Editor: F. L. KUNZ Associate Editor: E. B. SELLON Assistant Editor: MARIFRANCES WILSON

CONTENTS

Foundation for Integrated Education News and Notes		3
Integrative Concepts in Science, Philosophy, and Education Cell and Psyche	Edmund W. Sinnott	5
Formal and Operational Procedures in Science	Henry Margenau	10
A New Editorial Policy for Main Currents		17
Integration and Concepts	Harvey W. Culp	18
The Process of Evolution	Julian Huxley	20
The Promise of this Generation of College Youth	Hans Kohn	25
An Integrated Program for General Engineering		28
Reviews		30

AIMS OF THE FOUNDATION FOR INTEGRATED EDUCATION

The Foundation is incorporated under the laws of the State of New York as a non-profit educational organization. Contributions are tax deductible.

The corporate statement of Aims declares that the Foundation has been established:

1. To collect, create, and distribute authoritative materials which will encourage the development of unified overall concepts in education; to improve the balance of relationships between the physical sciences and the social sciences; to inquire into the phenomena of purposive activity in nature, man and the universe.

2. To assist teachers to understand and use such materials, and to develop an active, realistic, comprehensive philosophy which will communicate to their students the unity, coherence, and beauty of the world in which we live.

3. To remedy, solely by such educative measures, the conceptual and hence the ethical, social, economic, and political breakdown of our times, looking to a peaceful world order.

The members, associates, and staff of the Foundation realize that the progressive discovery of unifying over-all concepts concerning man and the universe is not a task to be performed successfully in isolation from the historical, social, economic, and political context of our times, nor in terms of application less than global.

The work of the Foundation is wholly educational, yet is referred constantly to the contemporary scene in all its aspects, no less than to the total available wealth of human experience and knowledge.

MAIN CURRENTS IN MODERN THOUGHT is published quarterly to call attention to significant contributions to learning currently being made by leading workers in the multiple fields into which knowledge has come to be classified. It relates these advances to each other and to the classical and contemporary views of Eastern, European and American thinkers. It is designed to save time for the reader by providing a vantage-ground from which the whole world of knowledge may be surveyed and kept in proportion as it moves toward integration. Its editors assume that the principles of art, the universals of philosophy, the laws of Nature and Man as formulated by science, and the truths of comparative religion, can be orchestrated into a harmonic, meaningful, ethical body of teachings which can and should be made the central core of curricular study in the educative process at all levels of development. In condensing text, square brackets [ ] indicate editorial interpolation. Three dots . . . in the text indicates a word, phrase or passage omitted in the interest of brevity or clarity. Other usages are standard. $3.00 a year. Foreign $3.50. Contributors to MAIN CURRENTS enjoy full liberty of opinion and expression in these pages. *Copyright 1952, by F. L. Kunz, Port Chester, New York, to whom all communications regarding MAIN CURRENTS IN MODERN THOUGHT should be addressed.* *Entered as second class matter April 13th, 1946, at the post office at Port Chester, New York, under the Act of March 3rd, 1879.*

THE FOUNDATION FOR INTEGRATED EDUCATION

NEWS AND NOTES

College delegates and individual participants are invited to the 1952 Workshop of the Foundation for Integrated Education on "The Methodological Background Common to the Sciences and the Humanities," to be held at Oregon State College, Corvallis, Oregon, from Monday evening, June 23, to Saturday noon, June 28. Chairmen will be Dr. Henry Margenau, Higgins, Professor of Physics and Natural Philosophy, Yale, Director of Research of the Foundation; Dr. George A. Lundberg, Head, Department of Sociology, University of Washington; and Dean Schiller Scroggs, of Oklahoma A. & M. College, Education Director of the Foundation. F. L. Kunz, Vice President of the Foundation, will serve as general secretary.

Registrants will be supplied with a detailed program, during May, and—upon registration—will be invited to summarize their views with respect to deductive methods in some branch of science or of the humanities, if they indicate their willingness to aid in this way.

Insofar as practicable these pre-conference papers will be distributed among all participants in advance of the session, and will form part of the background of the discussions.

Suitable papers will be made more widely available through the Foundation's cooperative program.

This sixth workshop of the Foundation will be opened by the Chairmen, who will provide orientation toward the method and purpose of the program, which is (a) to estimate the content and value of contemporary science and (b) to discuss the application of the methods of the physical sciences to other subjects, such as biology and sociology.

Each day integrative concepts and data will be brought forward and made specific by scholars in the several fields in which a given key concept or theme clearly has major importance.

The principals' addresses will be substantial in content, but not technical in form. Teachers in the humanities will not be impeded by the use of higher mathematics (for example) in making the concepts and contents their own.

The main object of the Workshop will be threefold:

1. To supply teachers not only with integrative key concepts, clearly stated, but also a body of supporting data, such as a teacher can use to exemplify the principles and make the teaching interesting.

2. To display the general and the specific bearing of the findings upon possible metrical treatment of measurement of social forces and factors, and to consider their meaning in the solution of ethical problems in a modern mass production and technological society of free men.

3. To consider the chief procedural questions involved in organizing those concepts into courses and curricula and administering them.

No special detailed preparation is required for participation at the Workshop, but participants might benefit by a prior reading of the Proceedings of the Stillwater Conference.

The program will begin with dinner at 6 p.m. on Monday, June 23rd, and conclude with lunch, Saturday, June 28.

An all-inclusive rate of $40 has been fixed, which covers room and meals. There will be no additional registration fee or other charges. As it is the desire of the sponsors that registrants may find it easy to bring their families, a rate of $25 has been fixed for a wife or a child.

COOPERATIVE PROGRAM

The Foundation's Cooperative Program on the frontier of knowledge among the colleges and universities of the country, announced in the last issue of MAIN CURRENTS, has been launched by the issuance of invitation to institutions already closely associated or familiar with the aims and purposes of the Foundation. These first institutions have been invited on a truly cooperative basis, as they have been asked to assist in the formulation of the details of the program and methods of procedure.

The response has been encouraging. At this relatively early date, the College of Arts and Sciences of Oklahoma A. & M. College and Southwestern in Memphis have accepted at the full annual scale. The College of General Education of Boston University has indicated its desire to join and a number of others have the invitation under consideration.

With the advice and assistance of those who have expressed interest, the program is rapidly taking form. Confidence prevails that this venture will be implemented by services and materials not otherwise available to colleges and that the sharing of experience and the results of integrative programs by cooperating institutions through this program will serve to advance the development of integrated education on a national scale.

MR. KUNZ'S SPRING TOUR

F. L. Kunz, executive vice president of the Foundation for Integrated Education, will discuss the present stage of the Foundation's specific program during his spring tour. Specific engagements are currently being finalized. His itinerary stands as follows:

Central and Southern Ohio, Indiana, and Illinois, April 21-24; St. Louis and nearby, April 25-26; either Oklahoma, April 28-30; and Route 66 to California, May 1-3; or Kansas and Colorado, April 28-30; and to Southern California, May 1-3; Southern California, May 5-16; Bay Region and Northern California, May 19-23; Oregon, May 26-28; Washington and British Columbia, May 30-June 6; and June 16-20.

Mr. Kunz will report upon the Foundation's cooperative program and its sixth summer workshop.

He expects to return to the East in August, via a northern route.

Mr. Kunz is in general limiting occasions to visits with curriculum committees and other faculty groups concerned with integrative programs in general education.

PERSONNEL ACQUISITIONS

Schiller Scroggs, A.B., A.M., Ph.D., Dean of the School of Arts and Sciences and Director of the Research Foundation of Oklahoma A. & M. College, whose addition to the Council of the Foundation was announced in Vol. 8, No. 3, of MAIN CURRENTS, has accepted the position of Educational Director of the Foundation. In this capacity, Dean Scroggs will bring his years of experience as teacher and college administrator to bear upon the developing educational program of the Foundation, especially in launching the present Cooperative Program on the frontier of knowledge among the colleges and universities of the country.

Dean Scroggs is also Chairman of the Committee on General Education of the Department of Higher Education of the National Education Association. His association with the Foundation for Integrated Education began with his attendance at the Montecito Workshop in 1949 and he was instrumental in arranging the Stillwater Conference in 1950.

Mr. Robert P. Whorf has joined the staff of the Foundation as Assistant to the Director of the Foundation's Research program, of which Dr. Henry Margenau is Director.

During 1952-53 Mr. Whorf has a Carnegie internship in General Education at Yale, on leave from the integrated studies program at West Virginia University. This provides also a close association with integrative developments on the campus where several most active members of the Council of the Foundation for Integrated Education teach. From these happy circumstances, many benefits should accrue for colleges now cooperating with the Foundation. Mr. Whorf's special interests are mathematics, physical science, and philosophy. He has attended all of the Foundation's workshops except Montecito, 1949, and will participate at Corvallis, 1952.

DR. MATHER IN ENGLAND

Dr. Kirtley F. Mather, President of the Foundation for Integrated Education, will attend a conference of university teachers at Swanwick, Derbyshire, England, March 27 to 31, on "The Vocation of the University Teacher." The conference, under the chairmanship of The Very Reverend Principal John Bailley, Dean of the Faculty of Divinity in the University of Edinburgh, is being arranged by the advisory group of the Christian Frontier Council and the Student Christian Movement. Sir Walter Moberly, chairman of the Christian Frontier Council and principal of the Royal Foundation of St. Catharine, Cumberland Lodge, is expected to make the opening address. Other speakers will include C. R. Morris, vice-chancellor of the University of Leeds; Dr. Marjorie Reeves of St. Anne's College, Oxford; Professor John Marsh of the University of Nottingham; and Professor D. M. MacKinnon of the University of Aberdeen. The majority of the members of the conference will be members of the faculties of British universities, but a few professors from the United States and the continent of Europe will be present.

MOTION PICTURE ON PROTOPLASM

The first motion picture film under the auspices of the Foundation for Integrated Education is now being produced. Titled "Protoplasm in Motion," and accompanied by sound, it records significant research by Dr. William Seifriz, Professor of Botany, University of Pennsylvania.

The structure and rhythm of flow in protoplasm and its reaction to various substances are pictured. Comment by Dr. Seifriz as to the implications of the experiments pictured accompanies the photography, which is directed by Mr. J. M. B. Churchill, Jr.

The film will be made available through the Foundation's cooperative program.

GRANTS RECEIVED BY THE FOUNDATION

Thanks to a timely grant from the Davella Mills Foundation for equipment and furniture and to an anonymous personal source for partial underwriting for new premises, the offices of the Foundation for Integrated Education have now been removed to and comfortably housed at 246 East 46th Street, New York 17, N. Y. The telephone remains unchanged, MUrray Hill 2-5672.

With this generous help and in these favorable circumstances, the work of the Foundation will be greatly facilitated.

INTEGRATIVE CONCEPTS IN SCIENCE, PHILOSOPHY, EDUCATION

The verbatim texts of all the lectures in the course in integrative concepts (being given at New York University and co-sponsored by the Foundation for Integrated Education) are being readied for the use of cooperating colleges. We here present as specimens lectures which will represent the sweep, the precise, yet diversified application, the clarity, and the emphasis on method which the course lectures are intended to balance equally.

CELL AND PSYCHE

Edmund W. Sinnott

Yale University

Dr. Henry Margenau:

Our course began with a survey of the key ideas in the physical sciences. You became acquainted, first of all, with the reputedly so difficult and unpleasant subjects of modern physics with all their paradoxes and their challenges to thought. You were then taken through the interesting field of geology and learned about the history of our globe and of life upon it. Your attention was drawn to the phenomena of life in all their aspects, and study was concentrated on the mechanical properties of protoplasm and upon the chemistry of life. The vastness of space was explored in our lecture on astronomy, and the problems of heredity and evolution were discussed by experts in these fields. All through the discourses, glimpses of philosophical method have appeared and unifying principles have, I hope, become evident.

We have now reached a point where the stream of our inquiry broadens out from the physical sciences proper to the larger concerns which carry the name, humanities. It is well known that strange currents are likely to appear when rivers broaden. Hence, to move past treacherous eddys safely, a particularly able pilot is needed. We are fortunate in having him in the speaker of the evening. He is known as an authority in the field of biology and has, by his writings and his actions, shown himself a capable philosopher and a distinguished student of the humanities. Coupled with this is a genuine interest in the living object of the humanities, which is man.

I am happy, indeed, to be able to present to this audience Edmund Sinnott, Dean of the Graduate School and Sterling Professor of Botany in Yale University.

*These introductory remarks of the chairman of the course are retained, as an exception in these reports, because of their bearing upon development of thought in the lecture series.

Dean Edmund W. Sinnott:

This course has covered a wide range of fact and theory. You have examined the universe, physics, chemistry, and biology and have seen how they all are related to each other. Astronomy is tied in with physics, and biology with chemistry. One cannot cut physics and chemistry asunder. It is impossible to divide science into small bits, as we used to try to do. The days of compartmentalization are over. This concept of a unified science with essentially similar basic concepts, a science which is in the best sense of the word integrated, is one that everyone is beginning to understand now and to which this course is making a great contribution.

But there is one integration that we have hardly yet touched here, the one between biology—the phenomena of life—and those phenomena that are man's chief distinction, those of mind, of psychology. After all, it is man as a conscious, feeling, thinking, intelligent being in whom we are chiefly interested. The purpose of my talk tonight is to suggest one means of integrating our concepts in this area with those of life in general as presented in the life sciences.

Since the turn of the century great progress has been made in biology. It has largely been accomplished by the application of the principles of physics and especially of chemistry to the activities of living things, by an assumption that vital activities are concerned with the same laws, the same fundamental orderliness, as in the lifeless world. Through this conception that the organism is a mechanism, we have learned a greal deal about protoplasm, about living stuff, and what goes on in it—its chemical changes, the action of specific substances like hormones and the nucleic acids, enzyme systems, energy relations, etc. We are beginning to understand the general phenomena of metabolism, those vital processes that go on in a living body. We are coming, in other words, to understand how the living machine *runs*. This is a very difficult subject but it is on the way to being mastered. Most of the triumphs of biology since the turn of the century have been in the field of metabolism or cognate aspects of protoplasmic activity.

Much less progress has been made in another aspect of the living machine—how it grows and develops. Protoplasm is indeed a chemical labora-

tory, but it also builds organisms. Organism is a very happy word. It pictures a living thing as an organized system. A fertilized egg, or other mass of living substance, grows into a specifically formed body. This is a familiar, but, nevertheless a most remarkable fact, perhaps the most remarkable in science. To explain it, biologists have tried to apply the familiar concepts of biochemistry—of specific substances controlling development, or organizers, of hormones, etc., and most of these have proven almost entirely unfruitful.

Something more is involved in living stuff than mere chemical characteristics. Professor E. B. Wilson, in his famous book on the cell, says: "We cannot hope to comprehend the activities of the living cell by analysis merely of its chemical composition. The cell is an *organic system,* and one in which we must recognize some sort of ordered structure or organization." Something integrates the various activities of an organism, relating them to each other as part of a coordinated system. The organism is the central fact in biology, and the autonomy of biology (and I think biology has an autonomy) rests on this concept of organism. Biological organization is an unsolved problem lying at the very core of biology. It is like a skeleton in the closet. Many biologists do not talk much about it because they cannot do much about it, but there it is, the central fact of integration and coordination during the development of a living thing.

This phenomenon of organization is evident in various ways but especially in normal bodily development. Growth correlations, so called, can be seen in any living system, even such a loose one as a tree. The growth of branches in relation to the main axis, the angle of the branches, all part of the tree, are coordinated more loosely than the parts of an animal body, but nevertheless are tied together. One part grows in relation to other parts. We can see this with particular clearness in the growth of a fertilized egg of an amphibian or sea urchin. Here the little egg divides one way into two cells, then another way into four, then again into eight, and so on. It goes ahead dividing and dividing as the young embryo develops. Everything is in step. It proceeds as though it knew where it was going! Even where we cannot follow particular cell divisions, we see this. A section of a little group of cells, about a cubic millimeter in size, which is going to make a fruit or a plant, looks like a chaos of dividing cells. Surely, you say, there is no order here. But there is, because out of that little mass of cells grows a very specifically formed organic body. Some of the slime molds are very exciting in this regard. Each of these little plants, if you want to call them plants, is a single, tiny, independent cell, which at a certain stage in its development feels an urge to aggregate with some 10,000 or 20,000 other cells, coming together and forming a little organism. Those cells climb around over each other, build up a little shaft, and finally make a specifically formed fruiting body, a cellular state. How does each cell know its particular job in that combination? As Driesch said in a famous aphorism, many years ago, "The fate of a cell is a function of its position." In other words, what a particular body of living stuff, or a particular cell, will develop into depends on where it is in the body, because the whole organism is a patterned system.

Biological organization is even more dramatic in cases where one modifies normal development by experiment. If you cut off the shoot of a plant, it will regenerate roots. If you sever the vascular bundles, they will reform around the cut, and restore connections again. Where a young animal embryo is divided into two cells you can kill one of them, and the remaining one will go ahead and develop, not into half an animal, but into a whole one. Legs cut off in developing tadpoles will regenerate. If an earthworm is cut in two, the head end will form a new tail. There is reason to believe that every cell in the body, given favorable conditions, has the capacity of forming a complete organism. It does not often do this, but theoretically it could. The tendency always is to restore a single, whole individual, and this has a very specific form. By its form we recognize it.

Organic form is thus the external, visible manifestation of the phenomenon we call biological organization, this organizing capacity of living stuff, this patternizing power that all living material has. Each one of us has developed from a tiny, fertilized egg. Growth, a metabolic process, we can begin to understand. But why is an organism not just a spherical mass of protoplasmic mush? It is because it grows under control, in some directions faster than others, and out of this embryonic process comes a whole organism, a whole human being.

This same integrating, regulatory control is shown in the maintenance of physiological processes, what we call *steady states,* particularly as to body temperature (which is constantly regulated), the amount of sugar in the blood, and other sorts of physiological regulations. Here not a structural equilibrium is involved, but a physiological one, what physiologists called homeostasis, the tendency to keep in dynamic equilibrium.

This regulatory behavior is remarkable, but there is nothing necessary about it. It is not something that is logically required. It can go wrong in all sorts of ways. Abnormal growth of many kinds—tumors, cancers, etc.—is familiar in plants and animals. These are not dead tissues. The cells are alive and apparently normal, or nearly so, but some over-all organizing control has been removed. We shall understand the problem of cancer, of abnormal growth, only when we learn what this normal control is that goes awry when abnormal growth is produced. There are obviously levels of organization—the cellular level, the level of the organ, the level of the organism—and degrees of

closeness of integrating control in the development of the plant and animal body.

The first problem that faces us is to relate this distinctively biological phenomenon to those that go on at lower levels, and this many people have tried to do. Some have suggested that organizing capacity has arisen in evolution through natural selection. This is doubtful, because one can hardly imagine that every living thing has had in its ancestry every kind of accident happen to it (some of them accidents that could only have happened in the laboratory) and become selected to them. Natural selection will not suffice. It is often suggested that specific substances (a hormone, an organizer, a growth substance) control development. The more we learn about these things the more we find that such substances are merely triggers, evocators, something that calls forth a regulatory response. There is no magic in organizing substances. They are like a nickel in a juke box. They start off something. There is some specificity to it, some difference—you cannot run a juke box with a quarter, or a dime. But the real trick of the juke box is not in the nickel but in the mechanism which it starts. A few years ago animal embryologists thought that in the so-called "organizer" of the amphibian embryo they had the secret of organization. This idea turned out to be a very great over-simplification. Men always try to make the universe simpler than it is. And often fool themselves.

The biophysicist has postulated the operation of bio-electrical fields to account for organization. Perhaps they do. Electricity is doubtless important. But the biophysicists, although I suspect the answer is going to lie more in their realm than in that of the biochemists, have yet not got the answer. There is a close similarity between an organism and the new and remarkable electronic calculators, but those things are not alive. There are many things they cannot do. You cannot teach one of them to write a sonnet!

Biological organization is a challenging and still largely unsolved problem. There is nothing mystical about it, unless one wants to be a vitalist. It can readily be approached by experimental attack in the laboratory, and many attacks are being made on it from many directions. I think that the science of the development of form—morphogenesis—is the basic biological discipline. This phenomenon of organization is what makes biology a science in its own right and not a particularly complex sort of physics or chemistry. I want to suggest that this central biological problem can be integrated not only with the physical sciences, but with the phenomena of psychology. The life sciences are in a strategic middle position, and if we can relate them with the lifeless universe below and the universe of man and the human spirit above, we shall have accomplished a major task. Biology is at the crossroad between the physical sciences and the humanities and social sciences, between matter and man. Our major problems all ultimately center in this remarkable living stuff that we call protoplasm.

Regulatory activity is characteristic of both development and behavior. All vital processes, as Professor E. S. Russell, a famous British zoologist has said, have *directiveness.* This is the common ground between the physical and the psychical. These two types of integration are simply two aspects of the same fundamental biological problem. Many people have been struck by this, Professor Russell, Ralph Lillie, and half a dozen others. Vital activities seem to be goal-directed, or as a philosopher would say, teleological. It looks as if a living thing knew where it was going in its development. As Needham once said, a blastula (the first step in the animal embryo) is trying to grow into a chicken. Purpose and teleology and final causes are unpopular words in biology because they often have been invoked to explain many facts. We say a giraffe's neck is long "for the purpose" of reaching high up into a tree. The "purpose" of leaves is to carry on photo-synthesis. Those are not real explanations—but loose scientific expression that have prejudiced us against the concept of teleology and purpose in biology generally. Let us not be frightened unduly by this bogey. The subject at least is worthy of a little speculation, and speculation is what I propose to indulge in now.

The thesis I am proposing is this: that biological organization (concerned with developmental and physiological activity) and psychical activity (concerned with behavior and thus leading ultimately to mind) *are fundamentally the same thing.* This may be looked at from without, objectively, by a biologist in the laboratory as a fact in his science, or it may be looked at from within, subjectively, as a direct experience of desire or purpose. Conscious purpose and the development of an embryo are so unlike that to think of them as fundamentally the same may seem ridiculous. Once is a phenomenon of general protoplasmic activity in development. The other is a phenomenon of the nervous system in man. But let us remember that the nervous system is simply highly specialized living stuff. It intensifies the general regulatory character of all living material everywhere. You may say that to think of the mind in a bean plant or a worm is absurd, but one may ask where in evolution, or where in embryological development, does the mind begin? It has to begin somewhere. I think the germ of it is present in all living material. All living stuff is irritable. It will respond to stimuli, even without a nervous system. We have all seen a sensitive plant, mimosa. It responds to shock but it takes about a thousand times as long as a nerve impulse to do so. Even single-celled protozoan can be "taught" a little. Plants can acquire "habits." They have the germ of memory,

though no nervous system. The relation between the mental and the developmental seems in some ways not too implausible. The basis of my argument is that the developmental norm or standard or "goal," set up in the developing organism is a manifestation of that same control that guides its behavior, that developmental integration, or directiveness is the same kind of phenomenon that makes behavioral directiveness, and thus ultimately leads to purpose and psychological phenomena. This is the decisive step in the argument. If you admit this, all the rest of my argument follows. If you deny this, it falls to the ground.

What do we mean, then, by a norm, or a goal, or a purpose in embryological development? It is something set up within the individual that results in development in a series of specific orderly steps and produces a final formed individual. A good example of this is the genetic constitution of a fertilized egg, which you have heard something about already. Here in a fertilized egg, from one of which each of us has come, is a series of thousands of genes. They are independent in their inheritance, as Mendel has shown. But they are so controlled that this group of genes somehow foreshadows the character of the organism that will develop out of it. This is the twilight zone of genetics. We have analyzed the fertilized egg down to its chromosomes and genes; we can map them in the egg and know exactly where they are, we have some idea of how big they are and what their chemical composition is. But the big gap is between that fertilized egg and the adult animal or plant. How those genes control development, each of them stepping into the process at just the right place and just the right time so that a specifically formed animal plant is produced, is a big enigma. There must be some general headquarters somewhere, some control, some organizing capacity that puts them all into step, some concert-master with a baton, who tells them what to do. The form of the body, is, so to speak, immanent in the fertilized egg. We can tell exactly what kind of a body is coming out of any fertilized egg if we know what animal the egg came from. Just as the form of the body is thus immanent in the egg from which it grows, so, I think, a purpose or psychological goal yet to be realized may be said to be immanent in the cells of the brain. In one case we are observing it from the outside, in the other case we are experiencing it from the inside. Physiological regulation is equally purposive. Homeostatis, regulatory physiological behavior may be looked upon not simply as a phenomenon of physiology, therefore, but as a satisfaction of some of our most basic bodily desires. There is no conscious purpose here, of course, but out of such reactions consciousness must have arisen. Consciousness is an inner subjective relation to protoplasmic regulation. As J. L. Henderson said, "Consciousness was never produced in the process of evolution merely as an impotent accompaniment of reflex action." It must mean something.

Each of us is inside a living thing, and we can learn a lot from this preferred position. Many biologists have neglected this very great advantage. Of course we can learn much about a living thing objectively, by looking at it from the outside. But, as the great embryologist Spemann says, we are "between two worlds." We are inside one of our specimens. In this way we can find out a great deal about emotions, sensations, desires, purposes, passions, aspirations. These are all among the manifestations of life, but what they really are we would never guess, if we did not experience them. Introspection, therefore, should not be frowned upon. It is often neglected by psychologists because it is vague and non-quantitative. But desire, the subjective experience of a regulatory norm or standard seeking to be realized, is what we feel by introspection. We cannot get inside a rat or an amphibian embryo and see how it feels, but we can draw pretty close parallels between that kind of regulatory activity and the sort of thing that we experience ourselves.

It is very easy to reduce my argument to absurdity by saying that any self-regulating machine may thus be said to have a purpose. How about a thermostat? How about a stretched bow having a "purpose" to shoot an arrow? How about the "purpose" of a stone to roll down hill? Perhaps one could derive such a conception of panpsychism from Whitehead's philosophy of organism; but such purposive machines, even Dr. Wiener's electronic calculator, are after all quite different from an organism. They cannot reproduce themselves, they have no regenerative capacity. They lack imagination, they cannot think or feel. Here the materialistic, mechanistic idea of life and the idealistic one come directly into opposition.

The advantage of the theory I have presented here is that it implies neither mechanism nor teleology, neither fate nor freedom, neither materialism nor idealism. It simply asserts that biological and psychological events are identical in their ultimate character. What philosophical theory is going to express them best will depend at last on what the biologists find is the ultimate character of biological organization. This is a biological problem, using the term biology in a very broad sense to include not only the work of men in the laboratory but of poets and painters and men of faith. Development and psychology are not so far apart as a comparison of their extreme manifestations might suggest. One cannot separate psychological from behavioral facts. Is breathing behavioral or psychological? The pecking open of its shell by a young hatching bird is simply the climax of its embryological development, but it is one of the first acts of the bird's behavior. Nest-building is a formative activity, but it is instinctive. Something is being produced. Instinct itself

is regulatory. William James says, "Primarily and fundamentally mental life is for the sake of action of a preservative sort. Secondarily, and incidentally, it does many other things." Now if a primitive purpose to survive is the basis of all psychical behavior, as I believe it is, one may well concede that such behavior, and thus all mental life, comes from the general, regulatory, organizing ability of living stuff.

Other evidence supports this idea. Dr. Gesell, the famous psychologist of young children, in studying the mental development of infants shows how one step follows another, in a very regular way, and speaks of the "morphogenesis" of child behavior. It is really a continued part of embryological development. He suggests that the same mechanisms may be involved in both. The early adaptability of mental life and its later rigidity resemble the gradual loss of potency in the embryological development. Both developmental organization and mental organization also may be disrupted and disorganized, as in abnormal growth, on the one hand, and abnormal psychology on the other. So-called gestalt psychology provides a further argument. This maintains that experience itself is patterned or organized. Dr. Koehler says that organization in the sensory field is a characteristic achievement of the nervous system. Protoplasm itself tends to be morphogenetic. The mind organizes sensations into gestalten. It sees things as wholes, as patterns, and not as individual sensations.

You may say that all this is interesting but far from explaining the mental life of man, and that is what we want to find out about. Tropisms and instincts and plant behavior are important but we seek to understand our own conscious mental life. The latter has doubtless grown out of the former though it is concerned with many things in addition to purposive regulated behavior leading to survival.

In development the goal, or the purpose, is a single whole animal. This is certainly very far from the stream of thoughts and purposes in our own mental lives, our stream of consciousness. But we should remember that the goal in embryological development changes with circumstances. You grow a certain kind of primrose at a low temperature and it has red flowers. At a high temperature it has white flowers. Its norm, its standard, is modified by the kind of environment in which it grows. The form of an echinoderm larva depends on the amount of lithium in the sea water. What a given gene will produce in inheritance is not an invariable characteristic. It will depend on the other genes, and on the environment in which the plant or animal is growing. A single gene has not one role, but a whole repertoire of roles, and this repertoire changes during development. The goals of physiological and psychological behavior also change with conditions. A simple sluggish animal like a clam has a very simple sort of psychological life, with very few physiological regulations, very few purposes. An insect with a constantly changing environment has physiological and psychological norms or purposes that change considerably.

In man this reaches its climax. One purpose and goal succeeds another, one idea follows another, but the differences are in degree and complexity, I think, and not in kind. Remember that any idea primitively results in action. This is what ideas always did at first and do now in the lower forms, apparently. But it does not need always to do so. We have learned the great knack of abstract thought. An artist may have the idea of a painting in his mind, but that does not mean that he has to paint it at once. He can think about it without putting it on canvas. The origin of abstract thought, of thus being able to have ideas in our minds without acting on them, extends our mental life far beyond the embryological, simple, protoplasmic, physiological states. Memory of things past, and imagination of things that might be, enormously enrich the life of the mind, but psychological phenomena are concerned first and foremost with regulatory, preservative action.

Thus all the conscious life of man, full of ideas, aspirations, intellectual subtleties, and emotions is simply the manifestation of an organized, biological system raised to its very highest level. The regulatory action of protoplasm in growth and physiology merges imperceptibly into instinct, and out of this emerges the complex mental activity of the higher animals and finally the rich life of the mind and spirit of man. There is no break anywhere. The basic problem is the regulatory activity of living stuff, shown in all types of biological organizations.

Such a hypothesis has a number of interesting implications, which I will mention very briefly.

First is the old enigma of the mind-body relationship. This has troubled men since the days of the Greeks, and before. We are not committed here to either materialism or idealism, as I have said. J. S. Haldane, W. J. S. Sullivan, and others maintain that this idea of organization is so important that science must ultimately interpret the world of matter and energy in terms of the biological concept of organism. They are inclined to think that organization is a major category in the universe, comparable to matter and to energy, and that physics will be enriched by biology, and that perhaps the poet and the mystic may help us to understand not only life, as they certainly do, but even the material universe. In other words, mind and body are parts of the same fundamental fact. The real enigma is what makes protoplasm regulatory.

Second, the problem of purpose has already been discussed. "Efficient" and "final" causes, as Aristotle called them, the causes that are behind or

the causes which exist in our minds, are really the same. There is no vital difference between them. A biological goal set up in a fertilized egg, or in a nerve cell, is a final cause. It is a purpose. We do not commit ourselves to what it is fundamentally—it is simply there. Purpose is an expression of biological organization.

Third, as to the whole conception of *values*. Many say that science has no concern with values, but that is a mistake. Values, in the last analysis, are indications of the direction of protoplasmic goals. Protoplasm has its preferences. It is moving toward something. You have all heard of the second law of thermodynamics, which states that lifeless matter is always going toward greater and greater randomness, greater disorganization. It is a curious fact, though living things do not violate the second law, the whole history of evolution and embryonic development shows that life is moving toward greater and greater organization. It is as though there were two tendencies in the universe, one going down and one going up. Values show the direction in which this remarkable material of which we are built tends to move. Protoplasm has its own natural history and so does the human spirit.

Fourth, the ancient question of the freedom of the will. Are we tied into a determinate system that will not let us do anything except what matter and energy tell us, or are we free? We can simply say that something has to tell us where we are going. What freedom means is that external factors do not tell us, but that we are free to develop the internal directives in our own selves. That is all that freedom really can be, and this hypothesis of ours makes an interesting approach to that question.

Finally, the whole question of individuality and personality. Protoplasm forms individuals, it organizes and individuates matter. It does not produce an indeterminate mass of stuff. If an organism is cut in two, two wholes are produced, not two halves. Each rounds up and makes an individual. Furthermore, each individual is different from all the rest. Professor Dobzhansky has calculated that there is not one chance in billions that there are now, or ever have been, two human individuals on earth genetically identical (except, perhaps, "identical" twins.) Individuality is rooted in living stuff, and protoplasm builds individuals. We can even think of the soul as the ultimate standard, the norm, the integrating factor, that builds an individual out of living stuff.

We could carry these speculations far into philosophy but this is not the place to do so. I have tried to show that living material, protoplasm, which is closely integrated with matter and energy at its lowest level, may with no discontinuity be integrated with man's psychological life, and thus with some of the deepest traits of his mental and spiritual behavior, at the highest level. Biology is at the crossroads between matter and spirit. Protoplasm is a bridge, anchored at one end to the simple stuff of chemistry and physics, but at the other reaching out into the mysterious dominion of the human spirit. It is in protoplasm that all the sciences come together, and it is here that science touches all the higher life of man. If we seek integrative concepts, it is in studying protoplasm that we shall find them.

FORMAL AND OPERATIONAL PROCEDURES IN SCIENCE

Henry Margenau

Yale University

This evening we begin the second term of our Course in Concepts, and it may be well at this time for me to summarize briefly some of the salient features that have emerged in the preceding lectures. I hope you will permit me to do this not in general terms, but in terms to which I am accustomed. Professor Northrop and I have, over the last ten years, developed a certain methodology of science; I shall use the terminology of that philosophy for my presentation.

This presentation might well be called "Facts and Fancies" rather than the somewhat colorless title I have chosen. Those who attended the first semester of the course will recall we agreed that knowledge starts among data, among immediate facts. These data were analyzed, and it was shown that they bear certain correspondence with concepts, with ideas. These sensory data are, in Northrop's terminology, *concepts by intuition*, which somehow present themselves with immediacy in our experience. They include the colors, the shapes, and the sounds that make up our external, or perceptual, apprehension.

On the other hand, there are ideas—*constructs*, as I like to call them—which stand in correspondence with, or relate directly to, these immediate facts. It is the characteristic of these constructs to be manipulable by the laws of reason. Because of this they are fertile, they are fruitful, and, whenever they are present, the science which they enliven becomes a going concern.

In order to recall the relationship between sense data and constructs more vividly to you, let me restate this in another way, using the results of an earlier lecture.

There is, on the one hand, what I like to call the P-plane, the plane of perception. This plane of experience comprises our sense impressions; here we make our observations and define the operations which form the bases of scientific pursuits. On the other hand we have the C-field—the field of constructs, *concepts by postulation* in Northrop's terminology. These constructs are somehow correlated with things on the P-plane by ties called *rules of correspondence,* or epistemic correlations, or interpretive definitions. They go by many names; they are always present, even though sometimes unrecognized.

Let me illustrate this. We see certain objects in our immediate experience. They may be trees; they may be people; they may be apples or marbles, but in any case, whatever they are, we are able to count them. Now counting is an operation or, if you please, a method of observation. Through this process of counting we define a number—1, 2, 3—and this number is the ideal counterpart of a certain aspect of our immediate experience. The point I wish to make is that whenever a field of endeavor, a discipline, is replete with both observational elements (is full on the P-plane, in other words) and has also a satisfactory number of constructs, ideas, or imaginative content (in the C-field) associated with it, it is a full-fledged science, predictive as well as descriptive, and useful in every sense.

The simplest example of a scheme of this type is one such as I have already begun to discuss: the marbles mentioned above. These marbles, which constitute our percepts, our data, if present in any considerable quantity, do not immediately suggest a specific number to us. To arrive at a number, we go through a careful series of observations and operations. We must first count accurately before we can arrive at the integers—1, 2, 3, and so on. We then can begin to organize the system of integers in an elegant, logical fashion, and so arrive at the laws of arithmetic. It is only when these laws have been firmly established by such exact operational methods that it becomes possible to make predictions. We are thus able to perform complicated calculations which we would not have been able to make had we nothing but the immediate data—the marbles—to work with.

This illustrates the usefulness of a formal science like arithmetic when it adjoins itself satisfactorily (by certain rules of correspondence) to the facts of our immediate experience. This total interplay is what I should like to discuss tonight: the mutual fertilization which takes place in any going, useful discipline between the P-plane—the plane of operations, of perception, of observation—and the C-field—the ideational, ideological, imaginative field of endeavor.

But let me first cite another example. I have already indicated how an abstract scheme such as the number system just mentioned can be useful in stabilizing our factual experience. Another instance may be added. There is nothing in our immediate observational experience that corresponds to the number zero. It is therefore understandable that it did not become known for many years, until the Hindus invented it. When it was added to the sequence of numbers, nothing really important happened on the P-plane, on the plane of data and of immediate observation. New facts were not suggested by the recognition that situations occur in which there are no apples, fingers, marbles, etc. But the addition of so unpretentious a construct as zero to the entities of arithmetic converted arithmetic into that most extraordinary and powerful tool called algebra. Thus an increment in the field of pure ideas rendered immediate observations more tractable and made prediction more powerful.

The transition from immediacy, from data, from pure observation, to constructs suggested by these observations, to ideas regularizing them, takes place everywhere, in all spheres of life. For example, one is rarely satisfied in noting a mere regularity among facts. The regular sequence of day and night which impresses every observer excites no one merely by reason of its invariability. There has never been a culture, no matter how simple and primitive, which has been content with the mere recognition or knowledge of this fact. Man always wants to know *why,* and the earliest explanations of the diurnal sequence, mythological speculations though they were, and inadequate from our point of view, nevertheless satisfied this human need to know the "why" of things—the need for constructional, ideational counterparts of bare facts. Today we do not conceive of this regularity of sequence between day and night as a mere statistical correlation. We explain it by invoking the theories of astronomy, and in terms of these ideas we are able to satisfy our need to know why.

The phenomena of birth and death are equally regular, equally inevitable and universal. Yet the fact that death always has ended, always will end, every life makes no one reconciled to his own life's ending. The fact alone is indeed highly unsatisfactory, and we long for some palatable explanation. Today we are without a scientific theory which will account for death in the sense of telling us why we must die. This lack has driven many to embrace rather fanciful notions of religious, materialistic or supernatural origin—notions which may be quite unacceptable from a

scientific point of view. The need for a theory which can satisfactorily explain this phenomenon is felt by all.

Because of this fundamental need to know why, I cannot agree with Mach's statement that theories are devices which we use for a time because of our inability to comprehend all the facts, but discard when the facts have become familiar. Theories are, on the contrary, an important and necessary component of scientific method at all stages and in all fields.

For the sake of accuracy, however, I should note here that the word "theory" carries a different and somewhat strange connotation to a number of experts in special fields, chiefly historians and men working in social science. When I say, with what seems to me rightful pride, that the physicist has a theory to account for this or that phenomenon, the historian is likely to reply, "Why do you want a theory? Facts, accurately reported, are what count. Theories are subjective intrusions into reality; they must be eliminated from proper historical research." I do not know whether this view characterizes the historian today, but this contrast in positions should be recorded. The deductive scientist, such as the mathematician or the modern chemist, looks upon theories as *necessary* tools in his pursuits. Historians and sociologists sometimes look upon theories as necessary evils.

Because of what is perhaps a natural inclination, I cannot help but reflect on this situation with some concern. It seems to me that the disciplines in which theories operate with avowed importance are precisely the sciences which can predict and can create. Those disciplines which limit themselves to recording facts, which confine their attention to relations among data on the P-plane, somehow succeed in doing no more than to reconstruct the past, or make the present plausible. I sometimes wonder whether the emphasis on (validated) theory in the physical sciences has something to do with the dire potency of these sciences—with the fact that the physicist can make atomic bombs (although the historian can easily show that there were never any atomic bombs in the past), whereas people working in the social sciences find it very difficult to create an institution that is new, such as a world government. But these thoughts are mere speculations and of course overlook many complicating elements in the social situation.

The interplay between facts and theories can be sketched in another way. It may be useful for us to look into a few historical instances in which theories were born, for these instances reveal to us what happens in the minds of men when a correlational, statistical field of facts is transformed into a theoretical, deductive science. Let us consider, in the field of mathematics, the theorem of Pythagoras which, as you remember, states that the sum of the squares of the sides of a right triangle is equal to the square of the hypotenuse. It happens that the knowledge which is expressed by this theorem was known long before Pythagoras. In surveying the land along the Nile, the Egyptians used what they called the 3-4-5 rule. They took a rope and made in it a number of equidistant knots, usually twelve. They turned the rope first at the 3d knot, next at the 7th, and then closed the triangle. By this method they were sure they had constructed a right angle. Hence they knew the facts of the Pythagorean theory, for they used them. Judged pragmatically, their knowledge was as potent and satisfying as that which Pythagoras initiated. But Pythagoras' achievement was that he was able to *see* the validity of the operation on the basis of the axioms of Euclidean geometry. Why were people's minds more satisfied when they saw this proof? Why did they attach the name of Pythagoras to the theorem, making the discoverer immortal? It is clear that when this proof was given, a loosely knit, pragmatically connected set of data was organized into a nexus of well-understood facts. As a result of Pythagoras' demonstration there shone through the whole theory of geometry a new illumination, a pervading clarity, which had not been there before the theory was born.

Let me give another instance. At the beginning of this century, physicists had made a great number of measurements on spectral lines emitted by various atoms. With respect to hydrogen, which is the simplest atom and gives the simplest spectrum, a Swiss scientist named Balmer developed a mathematical formula which reproduced the frequencies of all these spectral lines with amazing accuracy, to five decimal places. This theory was used by a great number of investigators and was found quite satisfactory for predictions. Then Niels Bohr came along and propounded the atomic theory which bears his name. Among other things, his theory showed that Balmer's formula was implied by his fundamental assumptions; in other words, he proved the formula. To be sure, the formula was not improved after the proof had been given, yet every physicist was elated and hailed Bohr as one of the greatest physicists alive. Why was this? Although Bohr added but little to factual knowledge, he illuminated the knowledge which was at hand and provided *understanding*. For this men hailed him, for there is, in truth, nothing so deeply satisfying as the understanding which a beautiful, elegant, mathematically sound theory engenders.

One can extend such a list of examples almost ad infinitum. Mendel's laws of genetics enabled perfect prediction of the results of cross-matings among plants and animals. Since they encom-

passed all the probabilities, why did Morgan become famous for his theory of chromosomes and genes? A gene has never been seen by the human eye, not even with the aid of the most powerful microscope. Yet experiments have shown that they do exist, and through their presence Mendel's laws of genetics become understandable. During the passage from a purely associative set of facts, statistically correlated, to be sure, and regulated by Mendel's laws, to a set of constructs —a broad interpretive idea called the theory of genes—the whole science of genetics came alive.

My thesis is that if we wish our thinking to be well regulated and successful, we must shun neither the observational, the operational, the immediate part of our experience, nor the theoretical, the ideational, the ideological part of our experience. Both must be considered. Biased emphasis on one or the other produces paradoxes and conflicts.

Let us review a few commonplace experiences in the light of these considerations. I am sure you have all read newspaper accounts of daily events, given with infinite detail, which filled you with disgust. Why was this? Was it not because the things reported seemed, in the end, inconsequential, trivial, commonplace, or even sordid? In other words, they were all on the P-plane, and there was absolutely nothing to give them significance, to link them with the C-field. There was biased emphasis.

On the other hand, it has been frequently said by idealists that values are unmeasurable, integral, and exalted above the need of operational analysis. I am as much disturbed by that attitude, for it too displays an inequitable distribution of emphasis, this time an excess of the rational and ideational elements in our knowledge. Such one-sided distribution of emphasis creates conflicts and antagonisms, in this case the antagonism between facts and values. We can never escape such conflicts unless we see the elements on the P-plane and those in the C-field in clear perspective and in their proper alignment.

Finally, consider such a firm, rich, and vivid subject as life itself. Why is it fraught with interest for everyone? Its richness comes from its manifest and unstinting reference to both realms, the immediate and the rational. Operationally, life is merely a set of biological processes like respiration, growth, reproduction, and death. But although these may describe life to some extent, they cannot define it, nor can they convey the whole significance of the phenomenon. On the constructive side, the idea of life contains the consciousness of striving, of sadness and joy, of hopes and aspirations, of the past in which life is embedded and of the future toward which it is set. A term like life has impact and reality because it refers to both realms.

At this stage I should like to become a little more technical, and develop for you the counterplay between fact and fancy as it occurs in science. I shall choose for this demonstration the science which is closest to my own interests, physics, and consider the meaning of a very simple and basic term: *distance*. Let us try to define it from the operational standpoint, and see how far we can get.

If we want to know the distance between A and B, we take a meter stick and lay it off between A and B. The number of times it is laid off is then the number of meters in the distance. This is a simple operational definition which belongs almost wholly to the P-plane. It is possible, however, that points A and B may be very, very far apart—even astronomically remote. Therefore, another device for measurement is needed: in the case of an astronomical distance, light. We determine the distance of an object by the time it takes for a beam of light to be reflected from its surface and to return. Since we know how many miles light travels in one second, and we have observed the number of minutes it took for light to return from the object, we can quite easily figure its distance away. This is a possible method of measuring distance astronomically. Now, however, we come to an important question.

Do these operations—laying off a meter stick and timing a light beam—have anything in common? Are we logically entitled to call the results of these measurements by the same name, to call them both "lengths?" Operationally, they certainly differ; we cannot identify the two. Let us see, however, if we can get out of the difficulty in which our operationalism has placed us. We may say that we have here two operations we can compare: a distance traveled by light in a small time with a distance measured by a meter stick. But we cannot let the problem rest here. Let us further analyze the operation of measuring the distance between A and B by laying down a meter stick. To do this, one must certainly go directly from A to B along what we call a straight line. But how do we know a straight line? We sight from A to B, assume that light travels along a straight line, and measure along the line of sight. This seems all right, but there is still a difficulty, for how do we know that light travels along a straight line?

Perhaps we can overcome this difficulty too, still retaining our operational attitude and limiting ourselves to the use of a meter stick. All we have to do is to lay the stick out along many different paths from A to B, and then select the shortest path. If the least number of times that the stick can be laid down is, say, 135, then the shortest distance between A and B is 135 meters. This seems quite simple.

But a very irritating consideration has been injected into this situation by a mathematician named Poincaré. Poincaré questioned all such measurements on the ground that no one knows what the meter stick does when we lay it down. It may possibly expand, or contract in different ways under different circumstances. Now at first glance such an assumption seems fantastic, and unbelievable. To counteract this impression Poincaré provides us with an interesting example. He presupposes a two-dimensional disk-like universe, and in this universe a peculiar temperature distribution. It is very hot at the center of the disk, but the temperature decreases as one proceeds toward its periphery until it reaches zero absolute at the edge of the disk. Material objects show the same behavior in this hypothetical universe as they do in our 3-dimensional universe. They lengthen when the temperature is raised, shorten when the temperature is lowered. But the inhabitants of this disk have no sense of temperatures and cannot discover the temperature change. Thus when they are offered a meter stick with which to lay out the distance from the center of their world to the outside, what happens? The meter stick is long when placed in the center of the disk, because it is hot there. As the periphery of their world is approached, the temperature lowers and the meter stick shrinks. Not only that, the people themselves shrink, as does everything they carry along with them. The meter stick continues to become smaller and smaller as they approach the confines of their world until it finally shrinks to nothing. And when this happens, they find that they can lay it out an infinite number of times in a finite distance. Thus they will say they have shown that the diameter of their world is infinite. What is more, these poor people have absolutely no way of checking this result, for there is no device within their means which will tell them they are wrong.

Let us now return to our experiment. How do *we* know that something doesn't happen to our meter stick as we use it in measuring? How do we know that it won't shrink a bit as we turn it in the direction of the shortest distance between A and B, and so throw our calculations off?

My purpose in citing this example is to make one point: so long as we confine ourselves to operational procedures, we cannot even define so simple and exact a thing as a distance. We need something more: a metric. The metric is simply a set of rules which tells us how to compute a distance after we have made our measurements: how to translate the result of an operational procedure into a scientifically significant quantity. That is to say, in order to get something meaningful out of the realm of operations, we have to inject an *idea*—such as that contained in Euclidean geometry, or in the theory of relativity, or in any other possible theory—and this idea stabilizes the operation to an extent which makes it possible for us to define distance adequately.

Any measurable quantity of science presents an interesting challenge for analysis from the present point of view. To take a few at random: Temperature may be measured with different thermometers, which will give varying readings. A mercury thermometer will say one thing, an alcohol thermometer another, and an optical pyrometer still another, etc. How are we to reconcile these different answers? There is no way based only on operational procedures. The significant aspects of temperature only become apparent when we address ourselves to the field of constructs—when we begin to realize that there is something besides operationally defined temperature, namely, kinetic energy of the molecules. The molecules, which cannot be seen, which cannot be experimented with directly, have certain qualities which also refer to the temperature. Temperature becomes then significant because this idea correlates itself, or corresponds, to the measurements in the realm of observable facts.

The same thing can be said of force. The engineer wants to define forces in terms of springs and balances—as measurable pushes and pulls. The modern physicist often disagrees, and says his force is defined quite theoretically as a product of mass x acceleration. Textbooks of physics have been divided between these two points of view: some say the only accurate definition of force is mass x acceleration, others insist that force is the kind of thing that can be measured with appropriate instrumental devices. These two schools are still not reconciled. But from the integrated point of view which I am trying to present, the term "force" would not be useful at all, if it were not definable in both of these two ways: once, by reference to masses and acceleration, i.e. by logical reference to other ideas, once in terms of actual physical operations.

It is not only in physics that this interplay is important. It is significant in all other sciences as well, including mathematics. Mathematics presents a long, albeit a fertile, controversy between the adherents of one idea of probability and those of another. To illustrate, suppose we throw a die—a regular unloaded die—a considerable number of times. If we throw it 120 times, and count the number of times which the faces appear, we find that each of the six faces comes uppermost approximately 20 times. Thus we say the probability that we shall throw a 2 is 1/6 (20 divided by 120), i.e. the number of times the 2 has appeared divided by the total number of throws. In other words, we count the *relative frequency* of the occurrence of a 2. This illustrates the relative

frequency *a posteriori* definition of probability. In order to find the probability of casting a 2, we must throw the die a great number of times, count the throws, and then compute the relative frequency. But the other school of thought disagrees that this yields a probability at all. Its proponents say that if you want to know the probability of throwing a 2, all you have to do is look at the die. Obviously the die has 6 faces. Since there is a 2 on one face, the probability of throwing a 2 is clearly 1 divided by 6. This is the Laplacian formulation of probability, sometimes called the *a prioristic* theory, or view, of probability, because it allows one to determine the probability prior to casting the die, and to determining the frequency.

It is apparent that the two definitions of probability have very little to do with one another. In one case we look at the die, see that it has 6 faces, divide 1 by 6 and get 1/6 for the probability. In the other case we do not consider the geometric shape of the die at all; we discover the probability solely by the operational procedure of noting the sequence of throws. Operationally speaking it is a miracle that you get 1/6 by both methods, for logically one definition is quite foreign to the other. Sometimes probability theorists argue heatedly which is right. My view is that each alone is incomplete; both are needed. The Laplacian formulation provides a sort of *theory* for computing what is to be observed in probability situations. Theory needs to be proven by practice; operations need to be stabilized by theory. What makes the science of applied mathematics into a useful thing is the peculiar correlation between an idea in the C-field and a method of observation on the P-plane. There are some aspects of probability where only one of these is available, and we miss the other. People in the insurance business would give a great deal to be able to arrive at a theory whereby they could determine the chance of death of a given group of individuals in an a priori way. They are forced, unfortunately, to make a lot of actuarial observations on living individuals before they can determine the probability. The theoretical element in their scheme is still lacking. Whether we shall ever have it is questionable, but we shall forever be striving after it.

I should like to survey a number of other fields very briefly in order to point out more fully the effects of relationship between ideas and observation.

Biology, for a long time, was a purely descriptive discipline. Old-style biology comprised chiefly zoology and botany, which have lost some of their interest at the present time. But a new trend has been introduced, symbolized by a new term: the life sciences. There has been an injection of vital ideas and theories, of broad interpretive principles like Mr. Kunz's symmetries and Mr. Sinnott's psyche. I regard these as most promising contributions because, whether correct or not, they tend to transform a static, purely observational field of research into something dynamic and alive with fascination. These new views, the idea of an organizer and the concept of biological fields, have actually created a new vigor in the science of biology. This is universally true. When ideas are introduced, even though they may be partly erroneous, a humdrum field becomes a fertile ground.

History is sometimes regarded as a careful tabulation of facts—a tedious business. But today history is emerging from this sterile routine through the work of historians like Spengler, Toynbee, and others seeking *meaning* in historical events. As a matter of fact, the preoccupation of many people with religion stems from the fact that religion is a broad interpretation of history. People feel the need of such a broad interpretation to offset the irrelevant, statistical correlation of particular events which they are offered as history.

Psychology today is turning rapidly into a deductive field. Psychoanalysis seems to be enjoying particular favor, and it is interesting to note that it is the psychoanalysts who are full of ideas about the libido, prenatal conditioning, and such things. Whatever the justification, psychoanalysis has enlivened psychology by injecting ideas into somewhat amorphous behaviorism.

There is another phase of psychology, just as interesting from this point of view: parapsychology. Why is this subject so unpopular with the scientists? To be sure, parapsychology deals with occult influences, like telepathy, telekinesis, etc., but scientists have nothing against conducting accurate observations concerning these phenomena. What repells them is the complete absence of satisfactory ideas and theories in this field. Why, on the other hand, is the untutored mind so receptive to parapsychological speculations? It is simply because the layman thinks there *is* a theory—one which includes spirits and the fourth dimension—a theory which he believes can be verified in terms of these occult phenomena. Whenever a theory is introduced, whether it be a good or bad one, life and interest spring up.

Religion is a fertile field for ideas. I suppose one might say that here speculation has been carried rather to an excess. Certainly there has not been the moderation on which the scientist prides himself, the balancing of constructs by observations. Here again we have an unfortunate bias—this time in favor of the C-field—which has created the conflict that parades under the name, Science vs. Religion. There is no reason why the excrescences of ideation that often go under the name of religion could not be reduced to a modi-

cum which science can accept. I believe this will in time occur, and that even this rather basic conflict will ultimately vanish.

In conclusion, I attempt a brief discussion of political science; but before I enter upon it, let us try to define our bearings.

The doctrine I have presented, which leads one to see that accomplishment of a stable balance between operational and formal procedures is a prerequisite for integration of knowledge, life, and culture, will be called the *panoramic* view. It places *all* sides of our experience in evidence. It contradicts the rationalist and the dreamer and calls him to useful tasks; it opposes the misguided empiricist who believes he can generate reason by squeezing facts. The panoramic view enlivens facts with fancy on the one hand and it seasons speculation with the earthy spices of actuality. But beyond all this, it holds a further lesson: integration is possible only through concepts, that is, in the C-field. "Facts don't integrate."

This could be pursued much further. On another occasion I hope to have an opportunity to show that if we want to go from one field of research to another, if we wish to see the connections between the various disciplines, we cannot hope to find them on the P-plane. There the path is blocked. We do find them in the C-field, where the transition is relatively continuous.

Let us now focus the search light of panoramic reasoning upon the crucial problem of our time. We are involved in a tremendous conflict between what is called communism and capitalistic democracy, and our side is not winning in the *ideological* realm. We seem to feel that our strength lies in the military sphere. Nevertheless I am convinced that this fight must be carried out, or at any rate will be decided, in the ideological arena, where we are now experiencing reverses. Let us analyze the reason for this.

Communism is a dogma, a teachable creed. Youths in all lands but ours argue heatedly about the correctness of the thesis of Marx, Engels, and Lenin. They pride themselves on being able to prove in a rational and convincing way that the system of capitalism suffers from internal inconsistencies and cannot survive. Those of us who have lived in foreign countries even before the era of cold wars know the fervor and enthusiasm of a Marxist expounding his creed, know the absolute conviction with which he believes in the logic of his point of view. He is an avowed rationalist with perhaps one weakness: he ignores many facts, but unfortunately not enough to make him an easy mark.

Let us now be equally frank about our own attitude. We are convinced of the superior value of our form of democracy, our freedom. Our knowledge of these is immediate, is P-plane experience, our love for them so deep and unquestioning as to blind us to the need for defending them in rational terms—in the C-field. Yet it is true that a person who has not *lived* our democracy, our freedom, can have no comprehension of it. A foreigner coming to our shores is perfectly sincere when he ridicules our slogans; he is bewildered, much like a trusting child with its background of fairy tales when it confronts the facts of life. Ours is a way of life and not a doctrine; we are setting it against a doctrine which is not a way of life.

The inference is clear: we must fill our appeal with *ideological content.* On the side of empirical apprehension, in the sphere of facts, our case is excellent, but we forget that facts by themselves never carry conviction. Our error is made more grave, and it easily escapes detection, because of an empiricist philosophical tradition in which at this juncture we happen to be caught. The mandate is that we recognize this bias and correct it by supplying a teachable doctrine of democracy which elevates it from the status of a feeling in our bones to a defensible thesis that commands conviction. Let our youth begin to argue the value of a free economy with a gleam in their eyes; let our newspapers dedicate themselves to the task of showing that, on the basis of rational principles, capitalism is *not* doomed; let our politicians stop worrying about individuals called communists and proceed to study and expose communism, expose it in terms it accepts, which are rational.

Now it happens that an emphasis on rationalism in this ideological conflict is not difficult to confer. Our economists have in fact been theorists for many decades. Sociologists and politicians frequently take them to task for their supposed theoretical bias. Whatever their failings are, they have produced magnificent rational arguments for our political philosophy. Open any modern treatise on contemporary economics and you will find ample material for argumentation and debate. We need to pull this material out of college texts and float it abroad; we must forge every available theoretical element of the logic of western economics into a piece of shining armor and enlist it in ideological warfare. Ideas are as potent as economic operations, and we have neglected them.

It seems to me that this situation is more clearly perceived from what I have called the panoramic standpoint. The welfare of the world as well as the meaningful advance of knowledge require a unique alignment, an unvarying correlation, between rational and operational or purely observational pursuits; they demand a balance between imagination and analysis. And we have been found wanting more often in imagination than in analysis.

A NEW EDITORIAL POLICY FOR MAIN CURRENTS

Developments of Conceptual Significance For Knowledge as a Cultural Whole Will Be Cited from all Fields

MAIN CURRENTS begins, with this new volume, what is to be a steady process of re-conversion to its original purpose. It will inform the reader of specific developments, in all fields, which have marked conceptual significance in the development of modern thought and of knowledge as a cultural whole. Such concrete items, and major new tendencies, can and will be cited from authoritative sources, and though not restricted thereunto, will, necessarily, include the physical, natural, and social sciences as important parts of the human situation. The ageless wisdom of antiquity will not be neglected. Indeed, by providing, in non-technical comment, an analysis of the implications of each advance in modern thought, the reader with little or no specialized knowledge in the field of each item's origin should be aided to convert diversified knowledge into unifying insight. Thus the reader who finds it impossible to keep up with the mass of specialized literature will be able through MAIN CURRENTS to keep himself securely oriented to enduring values while moving along on the frontier of the developing ideas of our times.

All items will be serially numbered for easy reference and will be accompanied by full data as to the persons and places of origin, bibliographical material, and cross references to other items, as well as comment pointing toward probable effects on theory and implications for other fields.

In order to achieve thorough coverage of pertinent literature, MAIN CURRENTS invites the aid and cooperation of qualified source readers to supply authoritative, reliable, and recent items of conceptual import, culled from the great masses of currently published scientific and technical material. Analysis of the items will be undertaken by qualified colleagues.

Coverage of the following list of American and British scientific and related periodicals is first projected. An * indicates musts for adequate source reading. In general the listings under each heading are noted alphabetically, i.e. the listings are not intended to indicate a preferential order.

The present list is but an installment in a systematic program. Archaeology, the arts, and other areas will be discussed later.

General: *Advancement of Science, *American Scientist, *Nature, *Science, *Science News Letter, Scientific American, *Scientific Monthly.*

General—Annual Publications: **Annual Report of the Smithsonian Institution, *Science in Progress.*

Philosophy: **British Journal for the Philosophy of Science, Journal of Philosophy, *Philosophy of Science, *Philosophy and Phenomenological Research, Monist, Philosophical Review.*

Mathematics: **Mathematical Reviews, American Journal of Mathematics, *American Mathematical Monthly, Annals of Mathematics, Bulletin of American Mathematical Society, Scripta Mathematica.*

Physics: **American Journal of Physics, Philosophical Magazine, *Physical Review, *Physics Today, *Reviews of Modern Physics, Proceedings of Royal Society of London. Series A.*

Chemistry: *Chemical Abstracts, *Journal of Chemical Education.*

Biophysics and Biochemistry: *Archives of Biochemistry and Biophysics, *Biochemical Journal, Biometrics, Bulletin of Mathematical Biophysics, Journal of Biological Chemistry.*

Biology: **American Naturalist, *Biological Abstracts, Biological Bulletin, *Biological Review, Biological Scientist, Cytologia, Ecology, Evolution, *Growth, *Human Biology, Journal of Ecology, Journal of Morphology, Natural History, Proceedings of Royal Society of London. Series B., Protoplasma, *Quarterly Review of Biology, Yale Journal of Biology and Medicine.*

Botany: *American Journal of Botany.*

Zoology: *Journal of Experimental Zoology.*

Psychology: **American Journal of Psychology, American Psychologist, *Journal of Abnormal and Social Psychology, Journal of Comparative and Physiological Psychology, Journal of Experimental Psychology, *Journal of Parapsychology, *Journal of Psychology, *Journal of Social Psychology, *Psychological Abstracts, Psychological Review.*

Anthropology: **American Anthropologist, American Journal of Physical Anthropology.*

Physiology: *American Journal of Physiology, Electroencephalography and Clinical Neurophysiology, *Journal of Cellular and Comparative Physiology, Journal of Physiology, *Physiological Review.*

Sociology:
American Journal of Sociology, American Sociological Review.

Medicine:
American Journal of Medicine, Journal of the American Medical Association.

Undoubtedly many more periodicals should be listed and many more should be checked as musts. No effort has been made to include all of the standard journals — particularly in chemistry and the applied sciences. The source list will be constantly enlarged. Suggestions are invited as to names of additional fields and journals, including those of the humanities.

Persons who would like to cooperate as source readers are invited to inquire further and indicate their field of competence and qualifications.

For those concerned in this operation, and for readers generally, it might be interesting to ask what is meant by "conceptually significant." A first criterion requires that the materials be scientifically meaningful and authoritative. A reader must distinguish in his sources, for example, between scientific pronouncement, and what might be called "literary formulations about science," which in themselves do not have scientific standing. The source reader who seeks to uncover relationships among diverse scientific fields, which activity is encouraged, must also be especially critical of the use of language. The same expression used in different contexts does not imply a generic meaning common to all its uses. Concepts get their meanings, at least in part, through the prescription of specific rules of usage, and a general criterion of scientific meaningfulness requires that all statements be either directly or indirectly (through their deductive consequence) related to directly observed facts. To assess the authoritativeness of materials, the reader must in general rely on his familiarity with the field, on his knowledge of the author and his other works, and the reliability of the publisher.

There is, however, a further difficulty to be considered and a danger to be avoided. Since materials which are of conceptual import and integrative power are of varying degrees of abstractness and involve either generalizations (inductions) from observed data, or the discovery, stipulation, or postulation of relationships obtaining among observed data, the source reader must exercise care to distinguish those inferences which are well-founded from extravagant and unwarranted speculations. Unfortunately there are no readily accessible infallible criteria for making such discriminations. In general, the reader should be guided by those methodological features of modern exact science which give it such authority and richness. The materials most desirable involve concrete data about those concepts and conceptual schemes which meet the methodological requirements of modern science, have deductive productivity, mathematical precision and rigor, logical coherence, and empirical verifiability — in short, concepts which may relate, unify, and integrate diverse natural phenomena.

INTEGRATION AND CONCEPTS

Harvey W. Culp

Foundation for Integrated Education

"As a man thinketh in his heart, so is he." Thus, if a man thinks in his heart that he is but an animal, the whole conduct of his life will be so ordered. If he conceives life to be an unrelenting struggle, he will approach every situation armed for combat. If he accepts the concept that this is a limited universe in which there is scarcely enough to go around, he will compete and hoard and struggle to have and to hold. If he believes that "you can't change human nature," he will fatalistically accept and seek to preserve the status quo and will view wars as "inevitable." And so on through a vast catalogue.

Man "thinks in his heart" in terms of concepts. They color his conduct and his view of experience. They are extremely important.

Human experience is not passive. Humans are endowed with the peculiar capacity to shape worlds of their own by words, feelings, and abstract thoughts. Because of this uniquely human capacity, everyone brings to each new experience not only his own personal equipment of sense organs but also his equally personal set of meanings, feelings, and abstractions.

Our senses and nervous systems enable us to *perceive* things and events in the world, ourselves,

and other people. We bring to each *perception* our own ideas, feelings, private meanings and abstractions, our *conceptions.* In the light of experience, long or short, rich or barren, every human not only *perceives* life and the world but each "interprets" or "reads into" every perception meanings based on the general ideas he holds in his mind.

These concepts are at work continuously, whether we are aware of them or not. In truth, their *unnoticed* persistent pressure gives them a remarkable unnoticed power over our actions.

Sub-human manifestations of life can only *react* to stimuli, situations and signals. Aside from "instinctive" patterns of behavior inherent in each species, every individual sub-human must learn anew the modes of behavior in life. Humans are free to *act* ("intelligently") by making their responses to stimuli, situations, and signals not only in accordance with what they *perceive* them to *be,* but also in accordance with what they *conceive* them to *mean.* Moreover, because humans use language and symbols, each new member of the species, each new generation, can bring to bear in its life the experience of its predecessors and contemporaries, using their concepts as its own.

That individuals may perceive more clearly, or more accurately, men have devised glasses, hearing aids, and such that, by better perception, they may live safely, well, and long. That they may live safely, well, long, cooperatively, and understandingly in groups, concepts have been passed from generation to generation in all families, tribes, and societies throughout all human history. Whatever form this passing on of concepts (ideas, meanings, facts, truths, morals) has taken, it is *education.*

In simple societies and in small family units concepts tend to be related one to another. They "hang together" and give the member of the group an over-all sense of security in the general meaningfulness of all experience. On whatever intellectual level he may be, such a person does not find it difficult to act "intelligently" in terms of his own and his group's experience to almost any situation he may encounter. By so much, his concepts, being related, are *integrated* and, by his certainty of action according to these concepts, he, himself, may be said to be an "integrated person."

As societies or groups became complex, group living required division of labor and the cooperation of specialists. In modern societies this process has reached a state in which the concepts of many groups of specialists are either poorly understood by, or unknown to, other specialists. What is worse, the non-specialists, or "average persons" are even less cognizant of these concepts. And the mass of "average persons" are not only the consumers of the fruits of the efforts of all the specialists but, in democracies, they are the ultimate controllers and governors of society. They therefore live by and among, and are required to regulate, artifacts and forces which have concepts behind them of which they are quite unaware or, at least, do not understand. Education may attempt to convey to the average student the concepts of the world which the specialists have changed or created. But most frequently such concepts become lost in a mass of facts. Where they may be individually clear they are rarely related to or *integrated* with each other. Such relatedness or integration into a general pattern by which life may be lived meaningfully is vital, inasmuch as individual ethics or social actions are referred to the basic conceptual view of the world, and of a life, and of the forces operating therein.

In this degree, the great mass of people in western cultures today are unable to conceive of the world and life as a meaningful whole. Their actions are accurate and adequate in those areas of experience where their concepts are clear. But they tend to become random, trial-and-error, simple *reactions* where their concepts are uncertain or inadequate. Moreover, because of conceptual specialization and the speed with which specialists have changed their concepts in the modern western world, a "cultural lag" has developed in that the great mass of people may *assume* their concepts to be adequate when in reality they are out-of-date in relation to the science, technology, and the forces current at any given date.

To remedy this present, dangerous situation, education, as *integrated education* based upon *integrated concepts* of science and philosophy, must be made available to all so that life may have a general over-all meaningfulness in reference to which the actions of all individuals and all groups may be used.

Confronting life in "one world"—made a neighborhood, relieved of wearing labor, and freed from pestilence and famine by science and technology; interdependent economically and politically; a melange of cultures; and a Babel of tongues—we shall be driven to neurosis, frustration, and the danger of mass suicide in proportion to the inadequacy of our ability to cope with life by means of concepts of its wholeness and its undergirding values. Social and cultural disintegration are the perils facing those peoples who are forced to improvise *reactions* as substitutes for human *action* guided by integrated concepts.

"As a man thinks in his heart" of a meaningful, understandable, unlimited, and on-going universe as a whole to which he, himself, is inextricably related, he may then, with such integrative concepts, enter into life with peace and mastery of himself and the forces around him.

THE PROCESS OF EVOLUTION*

Julian Huxley

The Importance of Verbal Concepts In the Human Phase of Evolution

I can think of no other saying more pregnantly apt to the subject of this last lecture of mine than this of Walt Whitman's in his "Song of the Open Road": "All parts away for the progress of souls. . . . Of the progress of the souls of men and women along the grand roads of the Universe, all other progress is the needed emblem and sustenance." It is couched in evolutionary terms; it is based on the postulate of progress; it brings out the value of symbols in supporting human effort; and above all it sets forth the soul, the individual personality at its highest and fullest, as the ultimate standard by which we must judge all other human achievements.

Medieval theology urged men to think of human life in the light of eternity—*sub specie aeternitatis*: I am attempting to re-think it *sub specie evolutionis*—in the light of evolution. I do this, I confess, in some trepidation: but the trepidation is balanced by confidence: I rely on the truth of the facts and ideas discovered by thousands on thousands of patient workers. What I can do is to suggest some necessary items for the agenda of the great discussion, in which we can all co-operate.

Psycho-social evolution—human history for short—operates by cultural transmission; and its units are communities based on different types of culture. I am neither an anthropologist nor a sociologist; so, luckily, you will not expect me to define terms like *culture* and *community* with any precision. I am a biologist, and as such I see human history as a recent and very special outgrowth of biological evolution. Without the biological background, it looks different. In particular, it looks different in the perspective of evolutionary time. To the historical specialist, the five or six thousand years of civilization seem intolerably long. But this is a minute interval to the biologist. Man is very young: the human deployment is in an explosive and very early phase. Man is the result of two thousand million years of biological evolution: he has every prospect of an equal or even greater span of psycho-social evolution before him. The human species has many grave problems before it: but it has a great deal of time in which to work them out—there may be some comfort in that thought.

The biologist knows how fruitful has been the study of the mechanisms of genetic transmission for understanding the process of biological evolution. He can properly suggest to the humanist that a study of the mechanisms of cultural transmission will be equally fruitful for understanding the process of human history. Ideas, rituals, symbols, transmissible skills, beliefs, works of art—these seem to be the chief vehicles of this transmission. In addition to the self-reproduction and self-variation of material substance, in the shape of genes, we now have to consider the self-reproduction and self-variation of mental activities, operating through the various media of cultural inheritance. Our analysis of biological evolution as a process has brought out a number of important facts and ideas—improvement, finite steps of advance, deployment, and the rest. The biologist knows that they will not be directly applicable in detail to cultural evolution, but he can be sure that they have their human analogies, and that equally important ideas will emerge from the study of human history as an overall unitary process, ideas which will escape detection so long as history is treated merely as a record of separate sequences of events. The Marxists have tried to avoid any such parochialism, and to treat history as a general subject. Unfortunately they approach it from a too-limited outlook, and without taking into account the relevant analogies from evolutionary biology. Unesco is now embarking on the same task in a broader spirit: let us hope that their *History of Mankind* will be the first truly scientific and comprehensive account of psycho-social evolution as a process.

The dominant beliefs of a community may have decisive effects on the lives of its members or on its own development. Thus the erroneous belief that death is never natural but is always attributable to some kind of witchcraft has led to the witch-smelling ordeals of Africa and has resulted in suffering or death for countless thousands of her people. The ancient Egyptians believed that kings and important personages could be made to live on in an after-life, but that their continued

*Excerpts from a series of lectures given in November, 1951, over the British Broadcasting Corporation, and published in *The Listener*. The series will be published in the fall in book form by Harpers and Bros. under the title, *Evolution in Action*.

survival there could only be ensured by continuing to provide them with real or symbolic nourishment. This belief eventually changed the economic life of the country, by transferring an increasing proportion of the land from more efficient exploitation under the kings to less efficient exploitation by colleges of priests.

It is easy enough to make broad statements about the steps of advance which have transformed the quality of human life and experience. We have the technical steps—the step from food-gathering to hunting; the domestication of animals and plants; the invention of the wheel and of building in stone; the development of urban life; the invention first of writing, then of alphabetic writing; and so on to the familiar triumphs of modern applied science. We also have the steps in the organization of thought and creative expression; the passage from thinking exclusively in terms of magic to thinking also in terms of gods; the origin of philosophy from mythology and of drama from ritual; the pursuit of learning for its own sake; the rise of the scientific method of enquiry. That, I repeat, is all too easy. What is difficult is to discover just how any one step is effected, still more to distinguish desirable from undesirable change, and restrictive from non-restrictive improvement.

That is the job of the science of man. Perhaps, I should say, the job of the human sciences, from psychology to history, from ethnology to economics, for there is as yet no single science of man, in the sense of an organized branch of enquiry with a common body of postulates and ideas. It is, I think, fair to say that the human sciences today are somewhat in the position occupied by the biological sciences in the early 1800s; they are rapidly exploring different sectors of their field, but still looking for a central core of general principles. One idea which came into my mind during the preparation of this lecture was that, in the human phase of evolution, the struggle for existence has been largely superseded, as an operative force, by the struggle for fulfillment. It is the combination of these two terms which seems to me important. Human life *is* a struggle—against frustration, ignorance, suffering, evil, the maddening inertia of things in general; but it is also a struggle for something, and for something which our experience tells us can be achieved in some measure, even if we personally find ourselves debarred from any measure that seems just or reasonable. And fulfillment seems to describe better than any other single word the positive side of human development and human evolution—the realization of inherent capacities by the individual and new possibilities by the race; the satisfaction of needs, spiritual as well as material; the emergence of new qualities of experience to be enjoyed; the building of personalities. But it cannot be achieved without struggle, not merely struggle with external obstacles, but with the enemies within our own selves.

There is also a struggle with the new problems that the process of change is always throwing up. To quote Whitman once more: "It is provided in the essence of things that from any fruition of success shall come forth something to make a greater struggle necessary." But the obverse of struggle is satisfaction; and satisfaction in the free enjoyment of one's own capacities is another essential thread in human life. Of course, not all fulfillment or all enjoyment is good or right, any more than all biological improvement is progressive. It is the business of moral systems to make such evaluations. But something of their goodness or rightness emerges when they are considered in conjunction with another key idea, that of participation.

The idea of participation in a common task, as against competition for slices in a limited cake, has already become widely current. We are getting accustomed to the idea of the participation of different nations in common jobs like defense, or the exploitation of natural resources, or the raising of the general standard of life. The idea can readily be given greater force and greater range by extending it to mean participation in the overall adventure of evolution. It then applies as much to realization of possibilities by the single individual as to human destiny as a whole. Other key ideas which emerged from our study of biological evolution were *flexibility* and *integration*. They are, I maintain, of general application in every aspect of human life, from personality to social structure.

Keeping these key ideas at the back of my mind, I shall devote the rest of my time to a few aspects of the human phase of evolution. The aspects I should choose as most important are as follows: the importance of knowledge and the organization of knowledge in the process of psycho-social transformation; the principle of limited but increasing certitude, as illustrated by scientific method; the ultimate wrongness of absolutism, in ideas as well as politics; the primacy of the human individual; and the need to keep human development open for the realization of new possibilities. These are all interconnected, each in a two-way relation with all the others, and it is impossible to present them briefly as part of a single sequence of argument. So I am reduced merely to outlining my themes as part of a total pattern of approach, trusting to my listeners to fill in the logical gaps.

A first principle, it seems to me, is one which has come up again and again during these lectures —the fact that progressive evolution involves the realization of new possibilities, but that this only occurs to the accompaniment of imperfections of every kind. This realization of new possibilities has continued during human evolution, though to the accompaniment of appalling suffering and frustration. As with biological evolution, the immediate view reveals only the struggle and the imperfections, and the short-term view mainly the dead ends and the failures: but once you look at

the process as a whole, a general direction becomes apparent. So we must believe in our own possibilities, both individually and collectively, while at the same time accepting our limitations. Our practical job is to keep human development open, to see how much fulfillment is possible, and how to reduce the amount of frustration.

A second major concept is the primacy of the human individual, or, to use a better term, the primacy of personality. This primacy of human personality has been, in different ways, a *postulate* both of Christianity and of liberal democracy: but it is a *fact* of evolution. By whatever objective standard we choose to take, properly developed human personalities are the highest products of evolution; they have greater capacities and have reached a higher level of organization than any other parts of the world substance.

Both of these ideas, in one form or another, have played important roles in history. The combination of the two in a broad evolutionary approach leads to a further thesis, that the nearest to an ultimate that we can discern in human life is not an absolute, but a trend—the trend towards greater realization of possibilities by means of the cooperation of integrated individual personalities. That sounds rather a mouthful; but once our minds have digested it, a great deal else falls into place. First of all, it clarifies the relations between the individual and society. Society is seen as existing for the individual, not vice versa. Social and cultural organizations, including the state, are necessary as instruments of order and vehicles of transmission and continuity in human life, but their most significant function is to provide means whereby more of its members enjoy richer fulfillment. If a society permits large numbers of its citizens to grow up without the means of enjoying beauty, or of developing their minds, it is not performing its functions adequately.

Next point: the individual has duties not only to society but to himself—or perhaps I should say to the possibilities that are in him. It is true that one aspect of his fulfillment lies in working for others; but another aspect consists in his enjoyments and the free exercise of his capacities. For after all, it is only through human individuals that the evolutionary process reaches its highest and most varied achievements. Each time you enjoy a sunset or a symphony, each time you understand an interesting fact or idea, each time you find satisfaction in making something, or in disciplined activity like sport, evolution has brought another of its possibilities to fruition.

Of course, the possibilities of man's inner life are as important as those of his active existence. The achievement of inner harmony in the building up of the personality is as important as was the development of self-regulating mechanisms in the evolution of the animal body.

This leads on to the subject of morality. Morality in the usual sense of the word is concerned with something outside the self—the individual's relations with others, with God, with society as a whole. But this needs relating with a morality concerned with the self—the rightness of free creative activity, of personal fulfillment. Psychiatrists like the American Erich Fromm have developed this idea in a very interesting way. And finally, for the evolutionary biologist, both must be related with a third sort of morality—the rightness or wrongness of the relation between man and his future. From this angle, anything which permits or promotes open development is right, anything which restricts or frustrates development is wrong. It is a morality of evolutionary direction. Here again, the Americans seem to be doing more than anyone else to explore the subject—I think of philosophers such as Charles Morris, with his book *The Open Self*.

Now I must pass to another of my main themes. Since man's evolution operates via his pooled experience, it is clear that the acquisition and the organization of knowledge are essential factors in the process. During the past three centuries a new general method of acquiring and organizing knowledge has been invented, or perhaps we had better say perfected—what is usually called the scientific method; and this, wherever it has been fully applied, has proved its superiority over all other methods. It operates on what we may call the principle of limited but increasing certitude, always ready to test its conclusions against experience by way of observation or experiment, but able in large measure to take effective action and to proceed to new subjects of enquiry on the basis of the facts and ideas already established. It thus combines flexibility with assurance in a unique way.

In scientific enquiry, different detailed methods are required for different subject-fields—those of physics and chemistry are inadequate to explore the fields of psychology and animal behavior. For a long time there was resistance to applying scientific method to the study of man. Now that a beginning has been made in the field of human affairs, we are finding out how much more complex this is than any other, and are having to work out all kinds of new methods for dealing with it; but there is no reason to doubt the eventual efficacy of the scientific principle of limited but increasing certitude in this field any more than in any other. In any case, we have to make the attempt. It is an essential method for keeping the process of understanding the world an open one, without restrictions on its growth.

This leads to my next point—the intrinsic wrongness of absolutism. It is generally accepted in the western world that political absolutism — totalitarian government—is inherently bad, because it degrades the individual from the dignity of a free

agent to the position of a slave, and substitutes commands and force for willing co-operation. It is bad because it considers individuals only as the means to an end, never as ends in themselves. But it is also bad because of its effects on knowledge. One way in which absolute power corrupts is this —the more absolute it is, the more it tends to invade freedom of thought and enquiry, and, indeed, the freedom of art and literature as well; we have only to remind ourselves of what happened in Nazi Germany, and what has been happening in the U.S.S.R. during the past twenty years. And freedom of thought and enquiry and creative expression are necessary pre-requisites for anything that we can consider as a full human life or as a social advance.

One obvious task for the free world to undertake is the scientific exploration of human possibilities. This has of course begun—to take but two examples, in the study of educational methods and of psychological capacities. But it has not yet been undertaken scientifically and systematically, from the point of view of exploring possibilities in general rather than establishing a number of isolated facts and conclusions. Immense opportunities are open. Thus, wrong methods of teaching may result in boredom and frustration and general distrust of one's own capacities. But right methods, as the studies of Piaget have shown even for the teaching of mathematics, show how education can be increasingly turned into a process of self-fulfillment. The mass of data gathered from children's art shows what important possibilities of self-realization are here available, and also shows how they are being neglected in all but a tiny fraction of developing human beings. The greatest opportunities, however, would seem to lie in applying scientific method to the exploration of man's inner life. The experiences of the mystics of all creeds and of the practitioners of Yoga prove what transcendent states of inner peace and unity of spirit the human personality is capable of. The systematic study of these possibilities of spiritual development would hold out the hope of devising techniques for making them more generally attainable.

But we must have a realistic background for all such explorations. We must face the fact that now, in this year of grace 1951, the great majority of human benigs are sub-standard: they are undernourished, or ill, or condemned to a ceaseless struggle for bare existence; they are imprisoned in ignorance or superstition. Here the possibilities are obvious enough, but they have not been realized in practice. This is the great reproach on the world's conscience. But once the terrible fact is properly grasped, it can become an incentive. We must see to it that life is no longer a hell paved with unrealized opportunity. The further fact that vast fields of possibility still remain unexplored adds inspiration and hope to incentive and duty. In this light the highest and most sacred duty of man is seen as the proper utilization of the untapped resources of human beings.

I find myself inevitably driven to use the language of religion. For the fact is that all this does add up to something in the nature of a religion: perhaps one might call it Evolutionary Humanism. The word "religion" is often used restrictively to mean belief in gods; but I am not using it in this sense—I certainly do not want to see man erected into the position of a god, as happened with many individual human beings in the past and is happening still today. I am using it in a broader sense, to denote an over-all relation between man and his destiny, and one involving his deepest feelings, including his sense of what is sacred. In this broad sense, evolutionary humanism, it seems to me, is capable of becoming the germ of a new religion, not necessarily supplanting existing religions but supplementing them. It remains to see how this germ could be developed—to work out its intellectual framework, to see how its ideas could be made inspiring, to ensure their wide diffusion. Above all, it would be necessary to justify ideas by facts—to find the areas of frustration and point out where they were being reduced; to show how research into human possibilities was providing new incentives for their realization, as well as demonstrating the means for realizing them.

In the long run, our actions are related to our overall picture, our map of reality. Any picture which leaves out the facts of evolution will be an incomplete and untrue picture, and will, sooner or later, lead us astray in our actions. Even an insect like a bee has to build up a three-dimensional map of the country round its hive to find its way about. It is in relation to the total picture of its surroundings that it steers itself in space. But man's surroundings are enormously larger, and in them he has to steer himself in time as well as in space. That is why his map must be a four-dimensional one. A three-dimensional map will help him to determine his position and chart his direction, but a four-dimensional one will also help him in choosing his destination.

But enough of cartographical metaphors. Human history and human destiny are part of a larger process. Only by getting some overall view of reality, in its dual aspect of self-transforming pattern and continuing process, can man hope to get a clearer view of his place—his unique place—in the process, and steer a better course into the future. This is my firm conviction, and if I have succeeded in any degree in persuading you of its validity, I shall be content.

Purely biological progress, in fact, has come to an end, but human progress is just beginning. There is a radical difference between them, which is correlated with the equally radical difference between any kind of animal life and any kind of human life. We begin by minimizing the difference

between animals and ourselves by unconsciously projecting our own qualities into them: this is the way of children and of primitive peoples. Though early scientific thinkers, like Descartes, tried to make the difference absolute, later applications of the method of scientific analysis to man have, until quite recently, tended to reduce it again. This is partly because we have often been guilty of the fallacy of mistaking origins for explanations—what we may call the "nothing but" fallacy—if sexual impulse is at the base of love, then love is to be regarded as nothing but sex; if it can be shown that man originated from an animal, then in all essentials he is nothing but an animal. This, I repeat, is a dangerous fallacy.

We have tended to misunderstand the nature of the difference between ourselves and animals. We have a way of thinking that if there is continuity in time there must be continuity in quality. A little reflection would show that this is not the case. When we boil water there is a continuity of substance between water as a liquid and water as steam; but there is a critical point at which the substance H_2O changes its properties. This emergence of new properties is even more obvious when the process involves change in organization, as in all cases when chemical elements combine to produce a chemical compound.

The critical point in the evolution of man—the change of state when wholly new properties emerged in evolving life—was when he acquired the use of verbal concepts and could organize his experience in a common pool. It was this which made human life different from that of all other organisms; and we can now begin to grasp the nature and profundity of the difference. The development of animals is always closed; their evolution is always sooner or later restricted. Man's individual development, on the other hand, is potentially open. It continues throughout his life, and it can take place in all sorts of directions: while in animals there is only one normal pattern to be realized. The same sort of thing holds for man as a type—his pooled experience can be indefinitely added to, and it can be organized in an indefinite number of different ways. Animal types have limited possibilities, and sooner or later exhaust them: man has an unlimited field of possibilities, and he can never realize all of them. He has developed a new method of evolution: transmitting organized experience by way of tradition, which supplements and largely overrides the automatic process of natural selection as the agency of change in the human phase.

This puts mind, in all its aspects, into the business of evolution. Thus, under this new dispensation, beliefs are inevitably brought into being; and once they have been brought into being, they become tools of living. And the same is true of ideals or purposes or scientific theories or religious systems—they are among the emergent properties of the new, human type of organization. They cannot help coming into existence, and then they cannot help becoming operative factors for further change. Thus, once life had become organized in human form it was impelled forward, not merely by the blind forces of natural selection but by mental and spiritual forces as well.

In the light of evolutionary biology man can now see himself as the sole agent of further evolutionary advance on this planet, and one of the few possible instruments of progress in the universe at large. He finds himself in the unexpected position of business manager for the cosmic process of evolution. He no longer ought to feel separated from the rest of nature, for he is part of it—that part which has become conscious, capable of love and understanding and aspiration. He need no longer regard himself as insignificant in relation to the cosmos. He is intensely significant. In his person, he has acquired meaning, for he is constantly creating new meanings. Human society generates new mental and spiritual agencies, and sets them to work in the cosmic process: it controls matter by means of mind.

It is not true that the nature of things is indifferent to the interests of man, for the interests of man turn out to be part of the nature of things. Nor is it true that science cannot be concerned with values. Science is a method of enquiry which can be applied in all kinds of fields. In any particular field, it has to deal with the subject-matter it finds there. In biology it can do something towards explaining the origins of conscious evaluation. But as soon as it is applied to man, it finds values among its data; you cannot either understand or control human affairs without taking them into account. For a science of man, the problem is not whether or not to have anything to do with values, but how to devise satisfactory methods of studying them and discovering how they work. Here again the operative method, the study of how processes happen, is the only one likely to yield positive results.

And so, in human life, the fact of progress is linked with the problem of destiny, in its dual sense of something to be obeyed and something to be fulfilled. Man alone is conscious of destiny; human organization is so constructed as to make men pose the problem of existence in this form. Ever since he first began, man has been groping to discern the features of his destiny more clearly. In the light of the evidence now available, he could come to the realization that his destiny is to participate and lead in the creative process of evolution, whereby new possibilities can be realized for life.

To draw this general conclusion appears to me as a real advance in thought. But it still remains to explore its implications and to study the means by which we might achieve in practice something of this destiny which is being revealed to us.

THE PROMISE OF THIS GENERATION OF COLLEGE YOUTH*

Hans Kohn

City College of New York

Youth, after the second World War, shows little of the "lost generation" feeling which characterized its parents twenty-five years ago. Yet the generation of the '20's faced a seemingly much more promising and prosperous scene both at home and abroad. Today it has become a trite though true commonplace that the United States, and the whole of mankind, is passing through a crisis. Scientists and moralists find ever-new adjectives to describe the multiple horrors which this crisis holds for the future. Escape into cynicism and dissipation would be timely under such circumstances, but instead, this generation of college youth has been sobered by the crises of the last fifteen years. It has started to re-appraise America's heritage and its position in the world.

The unexpected threat of Hitlerism and the even more formidable and unexpected threat of Stalinism have shocked youth into thinking about fundamentals. It has become increasingly clear that these threats cannot be met by military armaments alone. Arms are indispensable to guarantee national survival, but it would be a mistake to think of the danger as, above all, military. Nor is the threat of national socialism, whether of the German or the Russian type, directed solely against the free economic system, the only one so far that has succeeded in providing the masses with a high standard of living. Stalinism, as Hitlerism before it, challenges the whole fabric of liberal civilization. They deny and reject the very structure of the tradition which has grown up in western Europe and spread from there in the 18th century to the other shore of the North Atlantic. To this challenge the West has to find a response. Defense against an attack carried on by a fanatical faith is not easy. Is this generation of college youth prepared for it? Does the recent past supply spiritual arms for the necessary response which will demand a rethinking and a reinvigoration of the traditions of free men? Liberal arts colleges have to form the youth capable to do that.

Eighteenth century European philosophers and intellectuals saw in the unknown and distant English settlements in North America the possibility for the realization of their dreams of progress, the promised land, where virtuous men living in virgin nature would build the ideal society, fulfilling the hopes of the age of reason. But real nature was in no way as kind as 18th century Rousseauans believed. In the new continent, especially in New England, the settlers found a hard soil of scant fertility, immense primeval forests without roads or amenities, a wilderness which exacted an all-out effort to turn it into a place fit to live in. In this struggle against overwhelming odds, one side of human nature was developed to a degree unknown elsewhere, the man who builds and forges and constructs, the man who masters nature and gains proud confidence in his own self-reliant powers.

Thus America became the country in which the spirit of enterprise, of initiative, of an optimistic belief in the future of man, triumphed. It became the leading nation in technology, in applied science, in ever-new mechanical discoveries. But it paid the price. The American outlook became primarily utilitarian. Material conquests beckoned and brought ample and enviable rewards. But there was little time and little inclination for disinterested theory. The 'platonic pursuit of matters of the spirit and of beauty seemed a luxury. The United States became a center and a model of economic creativeness and of technological progress beyond the dreams of preceding generations. It did not become a radiant center of spiritual energy. In the 19th century the western European intellectuals abandoned their expectations of American leadership. They began to despise or pity the pursuit of the dollar and the cult of the machine. Only Europe's down-trodden and impoverished masses continued to look on America as a promised land.

But the achievement of America was at no time purely economic. That the United States became technologically the most prosperous country on earth was less important than the fact that it was politically the freest and most advanced land. Here the traditions of English liberty, the heritage of Milton and Locke, of habeas corpus and tolerance, grew into a universal message for all men, not only those of English descent, into a free society based upon respect for the individual, giving him scope for unfettered and spontaneous development, unknown even in England. But American well-being and political liberty no longer suffice. What is needed today, for the United States and for the Western world, is the assertion of the spiritual, non-utilitarian values on which, often without any articulate clarity, all American life from the days of the Founding Fathers until today has rested. These values alone have made the economic progress and the political liberty possible. They were inherited from the free societies on the other side of the Atlantic. In face of the challenges raised against these values, it is the task of the liberal arts college to prepare youth to meet this challenge and

*An address on the Seventh Annual Honors Day, Brooklyn College, November, 1950.

thus to re-establish firmly the foundation on which political liberty rests.

Higher education cannot exhaust itself in the preparation of young people for citizenship or for a place as well-adjusted useful members of society. This may be the purpose of all education. It is not the criterion of higher education. Useful knowledge is being imparted, and should be so to an ever increasing degree, in technical and professional schools. In liberal arts colleges, youth should pursue knowledge for its own sake. The higher intellectual and spiritual functions are disinterested functions. They do not lend themselves to any immediate practical use, but they open up higher forms of experience, they make men look out at ever wider horizons, they give profound and enduring pleasure and enlarge the understanding of life. They provide inner resources to face the trials and hardships, the frustrations and sufferings inherent in human life. Without them life would be infinitely poorer and ultimately meaningless.

The wrong attitude toward higher education manifests itself clearly in the approach to one of the foundations of all our civilized education. If one asks American students to study the classical languages and civilizations, one often receives the saddening answer, "Of what use can such a study be to me?" But liberal arts colleges fulfil their function only if they do not emphasize matter of immediate use or of so-called practical importance. To study languages, and in the first line the classical languages, is a most valuable discipline in itself, and as such to be welcomed, for nothing can be achieved in higher education without hard work, without disciplined dedication, without deep respect for intellectual values as such. In the closer acquaintance with classical civilization, which our Founding Fathers had, we are going to the roots of our civilization, to the sources from which its inspiration and its ability of regeneration have flowed throughout the centuries.

Instead of travelling this hard road to the sources, the present generation seems to rely more and more for its salvation on manipulating techniques. To the idolatry of technology has now succeeded the idolatry of social science and of psychology. Everybody is looking for peace of mind, or for panaceas to solve all the evils of the world through establishing well-adjusted averages. But higher education need not aim at creating too well-adjusted individuals instead of personalities whose minds and hearts continue to be agitated beyond the years of adolescence, not in an adolescent "idealistic" way but in a mature, critical and searching way. They should ask themselves troublesome questions without stipulating easy solutions or happy ends, knowing well that there are no answers, and certainly no ready-made answers, to many questions and many problems, no panaceas to the ills of the individual, of society, and of mankind. What Socrates did, we should all learn to do on our own small scale: to examine life with an open mind, weighing all the alternatives. In his never resting intellectual curiosity the old sage preserved his youth.

This is, however, no plea for eternal youth. Youth should leave the colleges as fully adult persons. There is no time any more for the protracted childhood, for the "kids" in their twenties, and the "boys and girls" in their thirties and forties, who people the American scene and adorn queerly the American language. Few among our college students will turn into scholars or artists or saints. The vast majority of them should not even try. But all of them should carry with them from the liberal arts college into maturity a keen understanding of, and a cheerful respect for, the disinterested pursuit of scholarship, the great works of art, the exemplary inspiration of saintly conduct. They should enliven and brighten American life with that gift of discrimination, which even without consciously expressed reasons makes them prefer a great tragedy to a musical show and a literary classic to the current best-seller. They should fully grow during their college years into the spiritual heritage of Western civilization, which in its origin has been a Mediterranean civilization, and in its modern form, since the 17th century, has become a North-Atlantic civilization.

The world events of the last decades have put an added responsibility upon the United States. Western Europe has shown during that time signs of spiritual fatigue. Fascism and Communism have spread their growing confusion of minds and hearts. The intellectual scene has been dominated by the feeling of frustration expressed in Franz Kaffka; by the emphasis placed by Karl Barth on the fearful abyss separating men from God; by the nihilism animating the heroes or rather non-heroes in Aldous Huxley's *Point Counterpoint;* by fear which Martin Heidegger, the representative philosopher of contemporary Germany, regards as the dominating obsession of man; by the idealization of the disciplined militant worker, a technological robot, presented by Ernst Juenger, the greatest writer of contemporary Germany; by the nausea of which Sartre speaks; by the labor of Sisyphus, in which the most gifted French writer, Albert Camus, sees the symbol of human life. These are only a few examples taken at random from the vast and varied scenery of the wasteland into which Europe was transformed as a result of the disaster of the first World War. These developments found their climax in the annihilation of man in Communism and Hitlerism. There the individual became the mere object of historical or biological forces, ruthlessly sacrificed to the inexorable march of history and to deified abstractions like race or class.

More and more Europe will be looking across the Atlantic not for dollars nor for free elections but for a new vitality giving hope and strength to

the spiritual life of the common Western civilization. Only a college youth deeply steeped in the values of this civilization, and courageously facing the realities and the difficulties of life ahead, will be able to help in this task. For the future will be very difficult. For many years to come, probably for the life-time of the present college generation, men will live in an insecure world with very little peace of mind. This world cannot be made more secure by wishful thinking or by moralistic preaching. It is useless, and often positively harmful, to believe that something is being achieved when well-meaning people exhort the nations to do away with greed or with distrust. These generalities avoid the concrete problems where all the difficulties lie to which we have to find an answer in the slow and hard way.

The number of misleading clichés which are thoughtlessly thrown around today is bewildering. We are told that in arms there is no security, which is true. But neither is there any security in disarming. Hitler and Stalin tried before 1940 to find security in armament and failed. Britain and we tried before 1940 to find security in disarming and failed. Panicky thinking helps as little as wishful thinking; an unbounded and unfounded pessimism which foresees the destruction of all life on this earth is as bad as an unbounded and unfounded optimism which believes in the sudden transformation of collective man into exemplars of wisdom and goodness. There were prophets of doom who foretold the annihilation of all civilization as a result of the invention of airplanes before 1938; similar prophets of doom appeared in 1945 with the invention of the atom bomb; they are now vocal with the invention of the hydrogen bomb; their prophecy of doom will be repeated at any new invention of that kind. Mankind certainly could lead a highly civilized life without aircraft and without atomic energy. But the wailing over these inventions will not solve the slightest of the concrete problems which we have to clarify, without fear and without illusions. The dangerous times ahead force us to live on higher planes of consciousness and conscience than we have been accustomed to. Here again, it is the youth trained in liberal arts colleges who should take the lead.

In the last three years the American people have made great progress in responsible thinking about the world in which they have to live. From March 1947, when President Truman announced a new American policy of support for Turkey and Greece against outside aggression, they travelled the road to the Atlantic Pact and to the United Nations action in Korea in an astonishingly short time. But this amazing achievement is in itself not enough. The American people must learn, and are learning, that they have to plan not only for a passing emergency but for a new period of history which will be with them for any foreseeable future. They are now beginning to awake to the realization of this unforeseen and unprecedented situation and of the obligating nature of their spiritual and intellectual heritage.

Twelve or fifteen years ago American college youth had little understanding of the values of Western civilization and of free society. The period of debunking had produced a cynical indifference to spiritual or moral issues which were regarded as clever rationalizations of corporate interests or individual greed. At an awful cost, Hitler has rendered us a service, by making us conscious of the danger threatening civilization. We have become conscious of its fragility and vulnerability. In normal or seemingly normal times — and who does not remember the return to normalcy after 1918 — we are taking our individual liberty and the values of civilized life so much for granted that we do not pay any attention to them and hardly esteem them. Only the sudden and unexpected dangers to which they have been exposed these last decades have awakened us to the realization of their nature. Today we know that life without them is not life at all. Thus it goes with most indispensable elements which we take for granted. We do not think of air or its value in normal times. But if suddenly we cannot breathe we know that there is nothing more precious than air. Ever present as air seems time to youth and therefore of hardly any value, until suddenly at a late moment men awaken to the irreparable loss of what now seems the most valuable of possessions. The opera *Der Rosenkavalier* deals with this subject in the unforgettable words of the great Austrian poet Hugo von Hofmannsthal, when the princess realizes the approaching inevitable end of her affair with young Octavian. In a passage unsurpassed in its musical poetry, the middle-aged and still beautiful woman becomes aware of the unique nature of time:

"Time, that is a curious thing;
If one just lives, it seems like nothing at all!
But then suddenly one feels nothing but it.
It is all around us, it is also within us.
All my veins feel its throbbing,
and between me and thee,
it flows in silence, trickles like sand
in the hour glass."

Thus it happens with liberty and with the security which law gives to the individual in a free society. In normal times it seems like nothing at all, one takes it for granted, but then suddenly, when there is danger of the knock at the door by secret police in the stillness of night, one feels nothing but it. In the years ahead, the liberty of the individual and the spontaneous growth of our spiritual heritage will be values which will be felt poignantly. College youth will have to understand and to sustain them.

The United States is growing into the unsought role of the guardian of Western civilization. It has become a commonplace to say that the center of

economic and political gravity in the western world has shifted to the United States. It is not yet always clearly seen that the chief responsibility for the spiritual invigoration of the Atlantic community, with its wealth of diversity within fundamental unity, has also devolved upon the United States. To higher education and to college youth go the responsibility and the honor of creating the conditions which might allow Americans, humbly and in painful consciousness of their limitations, to assume their share in this common task of the Atlantic community. In that field, more even than in the economic or military one, the fullest collaboration with western Europe is indispensable and carries in itself a great promise and hope. It is a positive and lasting aspect of an interdependence which is in no way confined to the momentary needs of security or prosperity. The foundations of the common Atlantic civilization were laid in the 18th century, when the English in Britain and the English in North America and the French entered into and kept alive an uninterrupted cultural exchange and intellectual conversation. These efforts are coming to fruition in our time. Perhaps 1950 may be in some respects nearer to 1750 than it is to 1850, above all in the feeling of growing interdependence as against national and nationalist limitations.

The threat which Stalinism presents to the Western world is not only, and not primarily, one of impoverishment and lower standards of living, and even not of the destruction of liberty. Stalinism meant also in Russia impoverishment and loss of liberty, but Russia had always a low standard of living, and liberty had there only a very short and precarious existence. Yet Russia, in the years before the seizure of power by Communism, offered the spectacle of a rich and spontaneous spiritual life, a marvelous growth of all the forms of beautiful art and searching thought which fertilized, in an uninterrupted stream of exchange, the writers and artists of the West. Stalinism put an end to it by pressing all intellectual life into an official straight-jacket. It destroyed contemplation and meditation, disinterested seeking and lonely daring, the foundations on which alone creative civilized life can rest. Wherever Stalinism spreads there descends like a blight a monotonous uniformity of all thought, an idolatry of purely utilitarian technology in the service of the state, an appalling poverty of intellectual discussion which has to conform to principles known beforehand, and of artistic imagination which has to conform to the mediocrity of philistine taste.

The spiritual threat of Stalinism challenges civilization. The response to this challenge cannot be found in economic prosperity; it can only be found in the ever-deepening and ever-broadening spiritual life of the Western world. This should be a powerful and alluring challenge to American college youth, worthy of their mature and informed thought, of their conscious and conscientious sense of obligation to the best in their heritage. The future is not known to man and pessimism is very widespread today, yet the future seems, in spite of great difficulties, to carry the promise of a richer life, if the new generation will accept the burden which the epoch they live in, the tradition they inherit, and the privilege of education, lay upon it. In that sense this generation is happier than the preceding ones, who entered the wasteland of the first half of the 20th century and found themselves helpless and discouraged before violent revolutions and devastating wars, before cynicism and brutality, nihilism and fanaticism. At the turn of the half century, however, at the bottom of despair, the awakening to a new affirmation of the values of Western civilization, in maturity and responsibility, in historical perspective and in mutuality with allied partners in the common civilization, may inaugurate a happier period, similar to the time of enlightenment when, as a fruit of the hopes of Western mankind, the American nation was born.

AN INTEGRATED PROGRAM FOR BASIC ENGINEERING

In late 1950 the U.S. Naval Ordnance Plant at Indianapolis requested Purdue University to consider the establishment of a graduate engineering program leading to the M.S. degree. After a number of conferences, a program was formulated late last Spring. Under date of September, 1951, the *History* and *General Considerations* of the program are described in *Report No.* 1 by W. E. Howland and G. A. Hawkins of the Purdue University Schools of Engineering.

The course is addressed directly to the solution of the problem that "The growth of technology demands an ever more effective system of engineering education for the increasing number of designers and inventors . . . as well as for the planners and administrators of our increasingly complex world. The defense and war programs have revealed the urgent need for more men of such energy and skill, but the need has existed for a long time and will be intensified as technical progress continues." The usual method of achieving these ends by increasing specialization is rejected because it means ". . . progressively relinquishing the goal of comprehensive knowledge."

Those responsible for this program recognize, as do most of us, that ". . . some specialization is

absolutely necessary . . . But this tendency has reached . . . a point of diminishing returns and the need has now arisen, especially in engineering, for more men whose range of understanding covers at least the main methods of thinking that have been developed in the so-called basic engineering sciences." This particular experimental curriculum has been devised to meet this need for broadening the scientific understanding of the specialists. In the introduction to this report, the statement is made that ". . . the specialist, so trained, will not only be better able to cooperate with his associates but . . . will be able to do a better job in his own field." Significantly, the point is made that "what he misses in detailed information he will gain in intellectual range and power."

The reason for this program at the Indianapolis U.S. Naval Ordnance Plant, where there is a group of excellent students and a highly-qualified managerial personnel, is the diversity of educational background possessed by the students, which makes it impractical to administer the large number of specialized master's level programs necessary to allow each to go more deeply into his own specialty. It was believed that ". . . the only type of a single program suitable for all of these students would seem to be one which is based upon the *fundamental concepts* that are common to all divisions of engineering." Thus it is that the essence of the program is *integration.*

To achieve this integration in engineering education, the course aims to tie together and to organize the "infinitude of infinitesimal" facts which are accumulated by the student in the course of his studies ". . . by the connective tissue of fundamental laws and principles . . . and the powerful method of mathematics." Emphasis will be put upon similarities of the basic phenomena and methods of analysis and synthesis in the engineering sciences, making a deliberate effort to extend the use of methods of analysis and synthesis to many fields.

Not only is it an aim of the program to break down the barriers between disciplines and specialties, but a continuous effort is being made to keep the connectives and coordinations ever before the student.

Quoting the original statement of aims of The Foundation for Integrated Education (MAIN CURRENTS, Vol. 5, No. 4) the assumption is made ". . . that (this) curriculum is an example on a limited scale of this much more comprehensive movement in the educational world . . . and that integration, once started in the technical area . . . might extend outward and, in the course of a student's life, reach to the more distant shores of his knowledge and experience."

Nowhere, perhaps, has the pragmatic result of integrated education (from the student's point of view) been stated better than it is in this report:

> . . . insofar as the common elements are not recognized by the student, engineering actually is to him complex. Very few of the actual problems solved in school will be met again in practice by any one individual. . . . He may not discover in any pigeon hole of his mind the exact prototype of the problem. If, however, he has at hand his "fundamentals" and has gotten into the habit of using them he will immediately start to work. He will try one tool after another using his favorite tools first in his own peculiar manner. A great deal of study may also be required but if he solves the problem it will be by the use of certain fundamental principles with which he is already thoroughly familiar.

The tentative course of studies in the program begins with "advanced engineering mathematics" applied to various fields of engineering. This is followed or supplemented by a course in physics, which will emphasize the basic physical laws, and other courses in circuits, machines, structures, and processes. The problems presented in all of these will resemble actual field, shop, and laboratory problems. "In all courses, detail will be sacrificed to generality whenever necessary to serve the higher goal of 'integration.' We want still to see the forest despite the multiplicity of trees."

Presentation is made in the report of the many publications which have recently "assembled material common to all engineers as evidence of the availability of appropriate material for the program." The prognosis of possible success of the program is soundly based upon the analysis of the problem of transfer of training and the principles of the method to be derived therefrom by Professor Eric M. Rogers.

Those who have set up this program have done so with full recognition of the problems which confront them, and the realism with which these problems are being approached bodes well for the success of the program. The field of engineering has been surveyed according to the variety of possible classifications of its content. The present program is set up about a classification according to "systems" which permits the material to be organized about the *kinds of thinking processes* employed by engineers and has the advantage ". . . of enabling the teacher to consider in a single course all of the design of analytical methods that are essentially alike, and to concentrate upon those central activities of professional engineering . . . which seem to be most in need of emphasis in a formal educational program." A considerable portion of the report is occupied by a careful analysis and discussion of methodology, modes of expression, modes of reasoning, etc. It all centers around the theme that "Education is a self-discipline, and hence every possible means must be made to stimulate the student so that he will *think for himself.*

One should not confuse the ability to analyze with the knack of acquiring a large mass of factual material."

It has been recognized by the creators of this program that, while the professional engineer is a scientist, he also practices the "art of engineering" by being able to handle a large amount of unformulated knowledge gained in his experience. It is acknowledged that this "art" is not only difficult to teach, but that the teachers are extremely few. However, it is posited that ". . . an introduction to this important phase of professional preparation should be made in the undergraduate years."

The "social humanistic stem" is regarded as being an integral part of the training of the engineer ". . . as essential to the development of the engineer as the blood vessels are to the body or the senses to the mind," to quote W. E. Howland. Ten pages of the report are devoted to a discussion of humanized engineering.

The engineer must be not only a trained technician and a scientist but because he has developed personally as an integrated human being, he must have developed also in the areas of the humanities, the social sciences, and philosophy. He must be trained to exploit his scientific insight to the fullest extent in all areas of living. He must also have an appreciation of the aesthetic quality of engineering science and the elegance of the scientific method. The report wisely concludes with the words: "The subject matter of science alone is an inadequate foundation for a liberal education partly because it fails to point out the aesthetic and philosophical values of science itself."

Everyone who is concerned with the problem in modern education realizes that, while it is imperative to bring science to the liberal arts student (in the manner to which the Foundation's current course, "The Frontier of Knowledge," at New York University is addressed), there is the equally imperative necessity of broadening the scientist and the engineer. This program seems to be extremely well-founded, well-documented, and sane. We shall watch its development with interest as it ". . . attempts to abandon conventional subject matter boundaries, to reshuffle the deck of engineering facts in a new way, and to play the game according to somewhat different rules. . . ."

The Engineering Schools of Purdue University and the officers of the Indianapolis Naval Ordinance Plant are to be congratulated upon the institution of this program. H.W.C.

REVIEWS

In his new book, *Science and Humanism* (Cambridge University Press, New York, 1951, 68 pp., $1.75) Professor Erwin Schrödinger expounds in his lucid style some of the philosophical implications of modern physics. He treats of the primacy of form, the problem of free will, and most especially the importance of science in the understanding of humanity. He succinctly states (on page 51):

"I do not think I am prejudiced against the importance that science has from the purely human point of view . . . I consider science an integrating part of our endeavor to answer the one great philosophical question which embraces all others, the one that Plotinus expressed by his brief: *who are we?* And more than that: I consider this not only one of the tasks, but *the* task, of science, the only one that really counts.

"But with all that, I cannot believe . . . that the deep philosophical enquiry into the relation between subject and object and into the true meaning of the distinction between them depends on the quantitative results of physical and chemical measurements with weighing scales, spectroscopes, microscopes, telescopes, with Geiger-Muller-counters, Wilson-chambers, photographic plates, arrangements for measuring the radioactive decay, and whatnot. It is not very easy to say *why* I do not believe it. I fell a certain incongruity between the applied means and the problem to be solved. I do *not* feel quite so diffident with regard to other sciences, in particular biology, and quite especially *genetics* and the facts about evolution. . . ."

Man Is a Microcosm, by J.A.V. Butler (Macmillan, New York, 1951, illustrated, 159 pages and index, $3) was most particularly recommended to the students in the course, "The Frontier of Knowledge," at New York University, as soon as it came to hand. In small compass the author—who is head of the Department of Biophysical Chemistry in the Chester Beatty Research Hospital, London—supplies the lay reader with most exact knowledge about the unique constitution of living cells, particularly proteins, employing photographs, diagrams, and tables of dimension to good effect. He does not so much reject, but shows the inadequacy and anachronistic nature of mechanism, and places man midway in the scheme of things.

"In the microscopic world, the smallest viable cell probably contains about a quarter of a million protein molecules of many kinds—and the larger ones many more. We find then in the smallest independently living units something like ten billion (10,000,000,000) atoms, united in many patterns of great complexity, and these patterns organized into a single functioning whole. There are about as many (or rather more) cells in the

human body as atoms in a single cell, so that the simple cell comes roughly midway in the scale of complexity between atoms and man.

"The body of a man is no negligible organization, even on the cosmic scale. What the simple cell is to the atoms, that is man to his component cells (Fig. 15). But another step in size of the same magnitude would include much of the visible universe! Man is thus in a midway position between the minute atoms of which the universe is constructed and the almost unimaginable whole. It is probably this which gives him his powers of coming to terms with and of understanding both." (pp. 150-151).

This admirable volume should stand on our working shelves of *little largesse,* along the Sinnott's *Cell and Psyche,* Sullivan's *Limitations of Science,* and Schrödinger's, *What Is Life?* Like them, it is free of the several groundless and misleading extrapolations found in Fred Hoyle's recent little volume of B.B.C. lectures, and that air of certainty and finality which is so destructive of inquiry.

The make-up of the cell, the biotic energy exchange, the world of enzymes, irritibility, and like topics are reviewed also in the thirty-six chapters of a larger book, *The Bridge of Life,* by Augusto Pi Suñer (Macmillan, New York, 1951, 266 pages and index, $3.75). Here the absence of illustrations is balanced by more text, and greater range of philosophy, from a philosophically minded doctor in the University of Venezuela, Caracas.

It is encouraging to see the return of interest in consciousness and the cognitive problem. We quote from page 259:

"We may imagine that after enormous difficulties we can some day arrive at an understanding of the acts of animals or of men and the fitness of such acts to physiological requirements. An objective psychology, like that attempted by Bechterev, might come within our reach at the cost of much effort. That is what Scheler called 'biology from without.'

"But 'biology from within,' the play of the consciousness, is a different matter. How does a particular animal —man—with the same functions as any other animal, with a similar anatomy and chemical make-up but with more differentiation in its organs and functions, acquire cognition of its inner profound reality and attain an existence which it finds within itself? How have 'I' come to exist and be 'myself' and nobody else?"

The author despairs of answering this question. Is this pessimism not based upon the incontestible fact that the conceptual meanings of 20th century science have failed to reach men and women even though the factual data is in their possession? The cognitive problem was beyond solution in the days of mechanism. It is now subject to new treatment. F.L.K.

The inevitable counterattack from the East, which C. E. M. Joad saw must come, is now developing in strength. Twenty philosophers have contributed to *Radhakrishnan, Comparative Studies in Philosophy* (Harpers, New York, 408 pages, $5). What the Chinese and Indian writers here say shows that the age of the European Orientalist is closed. These Eastern writers are quite conversant with the works of Windelband, Zeller, Max Mueller, and the rest, down to today. They are replying to these men, living and dead, in their own European terms. The situation of the last hundred years, therefore, is now reversed, and if the reader wants to see the penetration to which the European interpreter of the East is subjected, he will find it here. We especially commend for this purpose the last two chapters, "The Relation between Eastern and Western Philosophy," F. S. C. Northrop (Yale); and "The Universal in the Western and in the Indian Philosophy," P. T. Raju, University of Rajputana.

This is a significant, rich, and perhaps even historically important volume. There is even a certain strange, even unreal, atmosphere attending one's contemplation of its circumstances. For this book is addressed to India's most celebrated academic exponent of Indian philosophy, S. Radhakrishnan, on his sixtieth birthday. *That* is the man India has sent as her ambassador to Moscow. One is inclined to remark that if the American scholar and teacher will not provide the free world with a well-based ideology of liberty, perhaps India may do so.

We quote the concluding words of the book, (page 408) ending Professor Raju's contribution:

"If a synthesis of the Eastern and Western theories of the universal is to be systematically accomplished, we should find the clue in the above or a similar analysis. I say 'similar,' because one or more other forms of the universal may be discovered. As the difference between the three above universals is due to the differences between the dominant realms and trends of thought, it would be more advantageous to isolate the trends, study the nature of the universals consistent with them, and then attempt their synthesis. Nor is it safe to leave them in isolation. The philosophy which the world of today needs is a philosophy that gives to each universal its due prominence, and presents all in their proper relations to each other. Man belongs to the natural, ethical, and spiritual realms at once; so long as he lives in this world each has its importance for him. A harmonious synthesis of East and West would be a harmonious synthesis of the three, in which each find its proper place. The task should no longer be left to random and casual attempts. Academical philosophers would confer one of the greatest benefits upon the world by applying themselves deliberately and systematically to this work. And it has been the life-work of Professor S. Radhakrishnan, in whose honor this volume is being published and who, true to the ancient Indian tradition, is never wearied of emphasizing the primacy of spiritual values, to make the world feel the need for the new synthesis and prepare the ground for its welcome. May this contribution accord with his life's mission!"

The second, revised, and enlarged, edition of *The Evolution of Scientific Thought,* by A. d'Abro, has been handsomely issued by Dover Publications, Inc. (1780 Broadway, New York 19, $5). The fifteen portraits (Pythagoras and Euclid, via Faraday, to Minkowski and Einstein) add a rich human interest to one of the indispensible works of our time. The wise humanities teacher has been benefitting from this non-technical authoritative treatise for 25 years. It continues on its unique way. We deplore only the failure to supply an index. Another edition should provide this, in glossary form, we suggest.

THE FOUNDATION FOR INTEGRATED EDUCATION

246 East 46th Street, New York 17, N. Y.

President: KIRTLEY F. MATHER
Professor of Geology
Harvard University

Educational Director: SCHILLER SCROGGS, Dean
Oklahoma A & M College

Chairman: HENRY MARGENAU
Higgins Professor of Physics
and Natural Philosophy
Yale University

MEMBERS OF THE COUNCIL

Frank Aydelotte, Former Director, Institute for Advanced Study

Thomas W. Chrystie, Chrystie & Chrystie, 20 Pine Street, N. Y. C.

John M. Fogg, Jr., Vice-Provost, University of Pennsylvania

Roger C. Gay, President, Nasson College, Springvale. Maine

Robert S. Hartman, Professor of Philosophy, Ohio State University

Arthur Hood, American Lumberman, Chicago, Illinois

Clyde K. Kluckhohn, Professor of Anthropology. Harvard University

F. L. Kunz, Vice-President of the Foundation for Integrated Education, Inc.

A. Gordon Melvin, Professor of Education, College of the City of New York

M. F. Ashley Montagu, Chairman, Department of Anthropology, Rutgers University

F. S. C. Northrop, Sterling Professor of Philosophy & Law, Yale University

Gerald B. Phelan, Director, Mediaeval Institute, University of Notre Dame

J. B. Rhine, Director, Parapsychology Laboratory, Duke University

Schiller Scroggs, Dean, School of Arts and Sciences, Oklahoma Agricultural and Mechanical College

John A. Sellon, American Reinsurance Co., 99 John St., New York, N. Y.

Carlton M. Sherwood, Pierce, Hedrick & Sherwood, 30 Rockefeller Plaza, New York, New York

Edmund W. Sinnott, Director, Graduate School, Yale University

P. A. Sorokin, Prof. of Sociology, Harvard University

Julius Stulman, President, Stulman-Emrick Lumber Co., Inc.

Ordway Tead, Editor and Director, Harper & Brothers, and Chairman of the Board of Higher Education of New York City

Samuel P. Wetherill, Wetherill Engineering Co., Bryn Mawr, Pennsylvania

BOARD OF DIRECTORS

Kirtley F. Mather
F. L. Kunz, *Executive Officer*
Thomas W. Chrystie, *Counsel*
Henry Margenau
John Sellon, *Treasurer*
Julius Stulman

STAFF

F. L. Kunz, *Executive Officer*
Margaret Wagner, *Exec. Sec'y*
Marifrances Wilson, *Sec'y*
Harvey W. Culp, *Admin. Officer*
Robert P. Whorf, *Ass't to the Director of Research*

THE FOUNDATION FOR INTEGRATED EDUCATION

246 East 46th Street, New York 17, N. Y.

Please send me MAIN CURRENTS in Modern Thought, quarterly journal of the Foundation.

		U.S.	*Foreign*
☐	one year	$3.00	$3.50
☐	two years	$5.00	$5.50

☐ I enclose check for $..... ☐ Please bill me

Name.....

Address.....

.....

Please send a sample copy to the following:

Name..... Name.....

Address..... Address.....